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Biogeographic Assessment of Tomales Dunes, Marin County, California: Vegetation, Flora, and Invertebrates

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CONTENTS

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FIGURES

Peter R. Baye, Ph.D Coastal Plant Ecologist
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Figure 20. Pondweeds (submerged aquatic vascular plants) *Potamogeton foliosus* and *P. nodosus*, Tomales Dunes

Figure 21. Natural pioneer *Abronia-Ambrosia* dune forb vegetation

Figure 22. northern salt marsh bird's-beak, *Cordylanthus maritimus* ssp. *palustris*

Figure 23. Dune tansy, *Tanacetum camphoratum* (southern form)

Figure 24. Garter snake, Tomales Dunes, northern dune slack, 2004

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1.0 Scope and Purpose of Report

Biological assessments of sensitive species are conventionally prepared for sites of proposed land use change in California, pursuant to various state and federal regulations, such as CEQA (California Environmental Quality Act), NEPA (National Environmental Policy Act of 1969), or ESA (federal Endangered Species Act). Biological assessments typically consist of either presence/absence surveys for sites within an artificial project boundary, or limited database searches for past reports of species occurrence at or near the site evaluated. The site boundary or "project footprint" bias of biological assessments distort a broader biogeographic perspective: the relation of the communities and species to larger geographic patterns of distribution. They generally focus narrowly on species with special legal status.

The tendency for biological assessments to emphasize legally elite species at the expense of other components of biological diversity may substantially underestimate cumulative impacts of land use changes on regional biodiversity. Rote searches of databases for reported historic localities of federal or state-listed endangered, threatened or rare taxa do not address the conservation significance of many other significant components of biodiversity. These include: populations of many non-listed but uncommon and declining "species of concern"; distinctive or unique populations of ecotypes (locally adapted, specialized genetic varieties), stable hybrids and introgressants (natural parent-backcrossed hybrids), old relict stands, geographic range limits or extensions, type localities (source populations of original definitive species descriptions) core populations (main populations, the sources of founders of new populations), and complex or distinction suites of species (i.e. unique communities).

Even for legally protected rare species, the biological assessments often emphasize short-term presence/absence surveys, or narrow spatial focus on reported species distributions. This emphasis tends to inflate the significance of negative reports based on poor or erratic past sampling, and may underestimate the biological significance of unoccupied suitable habitats of limited distribution within historic species ranges. It is precisely the distribution of suitable unoccupied habitat within historic ranges, in relation to the distribution of modern species populations, that is an important concern for conservation of endangered species – the primary goal of the Endangered Species Act. This conservation or recovery context is also usually lacking in biological assessments that focus on short-term presence/absence data.

This assessment of the flora and insect fauna of Tomales Dunes adopts a broader biogeographic focus than typical biological assessments. It gives full weight to species of limited distribution or taxonomic significance – objective components of biological diversity – without prejudice to their current legal status. It also considers the relation of biological resources at Tomales Dunes in relation to the larger distribution of landforms, communities, and populations to which they belong.

2.0 Tomales Dunes: geographic setting

Tomales Dunes, Marin County, California, is the dune complex that extends from Dillon Beach to Sand Point at the mouth of Tomales Bay, landward approximately 3.5 km (southeast), beyond Tom's Point (Figures 1, 2). It is roughly centered 38.24 degrees N,

122.96 degrees W (U.S. Geological Survey, Tomales Quadrangle). The dune complex consists of at least two dune sheets of variable ages. The conspicuous, active, mobile western and central dunes (popularly known as Lawson's Landing or Dillon Beach dunes), developed on top of older shallow marine sand deposits, comprise about half the dune system; this *younger, active western dune sheet* extends approximately to Brazil Beach (Figure 2, 25). The extensive *older, eastern stabilized dune sheet*, extending over bedrock and hillslope soils far southeast of Brazil Beach, is quite stabilized and concealed by coastal scrub, old eucalyptus plantings, and rangeland. The downwind extreme end of the older dune sheet occurs at a point north and east of Tom's Point, which supports local relict dunes of the same or similar age (Cooper 1967; Figure 2). The older sheet consists of stabilized U-dunes (see below). The younger and older dune sheets can be distinguished visually by the color of the sand: the older, weathered dune sands are yellowish brown or grayish-brown (due to yellowish iron oxide staining and organic staining associated with soil formation over millennia), whereas younger dune sand is relatively unweathered and whitish or gray-white. The sheets can also be distinguished in part by vegetation: semi-open dune scrub, *Ammophila*, or bare sand on the younger sheet, and dense, closed scrub or plantings on the eastern sheet. The transition zone between older and younger sheets occurs north of Brazil Beach, where the younger sheet irregularly overrides the older. The highest dunes (altitude of over 120 m; Cooper 1967) are associated with the older, easterly sheet where it overrides hillslopes (marine terrace, locally exposed where dunes have deflated to base level). The familiar "Dillon Beach dunes" are essentially identical with the younger dune sheet portion of the Tomales Bay dune complex.

Public access is confined mostly to the younger dune sheet west of Brazil Beach. The "Dillon Beach" locality of botanists (Howell 1970, Smith 1998) is not restricted to the dune sheet, and includes the maritime bluffs and hillslopes above Dillon Beach; conversely, much of the Tomales Dunes sheet is remote from Dillon Beach, and is closer to Tom's Point.

The Tomales Dunes contrast strongly with the two proximate dunes systems, Bodega Head and Point Reyes. The Bodega Head dunes are extensively stabilized almost throughout by plantings of marram, or European beachgrass (*Ammophila arenaria*) and bush lupine (*Lupinus arboreus*) established in the 1950s. They include small remnants of older dunes, but not an extensive complex of multiple aged dune sheets, and a relatively small portion of the dunes there climb over hillslopes or bedrock (Cooper 1967). Point Reyes dunes are more extensive along the shoreline than Tomales Dunes, and climb over mesas and hillslopes rather than recent marine deposits. The dunes at Point Reyes lack the large, mobile transverse unvegetated ridges and extensive dune slacks (wetlands) that are characteristic of Tomales Dunes. The historic structure of the San Francisco dune complex – a mosaic of mobile transverse dune ridges, dune wetlands and ponds, overriding older raised marine terraces and Franciscan bedrock (Cooper 1967) – is more comparable to Tomales Dunes.

3.0 Tomales Dunes: landforms and geomorphic features

The geomorphic structures and dynamic processes of Tomales Dunes provide the dynamic physical framework and substrate for its biotic communities. The principal features, or landscape units, and some distinctive features, are described below.

3.1 **Beach**. The beach consists of the intertidal *foreshore* (permanently moist sand), and the *backshore* area between the limit of perennial dune vegetation and summer high tide lines (seasonally dry surface sand). The beach is composed of fine-medium, predominantly quartz sand. The beach gradient is very gently sloping, with a wide backshore zone (recently 50 to over 100 m wide near Sand Point) consisting of one beach ridge or two welded low-angle ridges deposited over the winter beach face. The backshore is narrowest at the north end, and widens to the south, forming multiple beach ridges and enclosed backshore runnels or temporary ponds most years near Sand Point, a beach feature intermediate between a recurved sand spit and cuspate foreland.

The wide backshore (Fig. 3) is key for the extensive dune development. It is the abundance of fine-medium sand, and persistently wide "sand fetch" – the sweep-zone for dry backshore sand transported by onshore westerly winds – that are responsible for the exceptionally large dune sand accumulations in the active historic transverse dune system, and the large multiple relict foredune ridges. The beach sand is also well-sorted, with negligible coarse sand or pebbles, so lag surface "armoring" (accumulation of coarse particles on deflated sand surfaces, resisting further deflation) of the beach does not occur.

This wide, gently sloping beach profile is associated with wide surf and swash zones, and contrasts strongly with the coarse-grained, narrow, steeply sloping beach of modern outer Point Reyes (high-energy, plunging breakers and narrow surf/swash zone). The gently sloping beach profile and dissipative wave energy environment select for relatively fine sand grains. The wide ebb tidal shoal at the mouth and offshore of Tomales Bay is a major dynamic structural influence on the maintenance of the wide, dissipative beach profile. (Figure 1, 3) . It is the association of the Sand Point-Dillon Beach with this permanent Tomales Bay ebb shoal, and its associated shallow nearshore and offshore zones, that distinguishes it from the relatively steep, coarser-grained Point Reyes beach.

The beach is only slightly affected by vegetation in the short-term. The prevalent vegetation is sea-rocket, *Cakile maritima*, an annual to short-lived perennial European forb, forming thousands of low-growing, spreading clumps, where seeds are deposited in winter drift-zones. Minimal perennial native dune vegetation occurs on the beach, and has negligible influence on sand transport. European beachgrass (marram or marram grass, *Ammophila arenaria*) regenerates from storm-eroded fragments deposited in winter, and initiates embryo foredunes in the backshore zone. The abundance and distribution of young *Ammophila* clones in the backshore is highly variable among years, usually greatest following major storm erosion events resulting in scarps (vertical cliffs) in the beachgrass-dominated foredune. There are minimal local seed sources for native perennial dune vegetation, and it is therefore likely that the essentially European beach vegetation will persist.

3.2. **Foredune and relict foredune**. Cooper (1967) noted that the wide foredune zone, densely covered by *Ammophila arenaria* cut nearly cut off fresh sand supply from the beach to the dune system. The date of *Ammophila* dominance is not known precisely, but preceded the 1950s, when Bodega Head dunes were actively stabilized by mass-planting of marram. Cooper (1967) mentions early unsuccessful attempts to stabilize Bodega dunes circa 1925, and this suggests a likely period for the earliest deliberate attempts to stabilize the

Dillon-Sand Point beach foredunes. Spontaneous colonization of Dillon-Sand Point Beach may also have occurred at or before this time.

The current foredune system consists of an outer, active foredune ridge at the back of the beach, and a series of partially fused relict, stabilized former foredune ridges, forming a high, irregular terrace or plateau. At least two relict ridges, likely remnants of former beach/foredune positions, can be visually distinguished at some points, but most of the stable foredune zone is irregular and hummocky. Natural California foredunes, dominated by wide hummocks of beach-bur (*Ambrosia chamissonis*) and yellow sand-verbena (*Abronia maritima*) (Figure 21) are displaced at Dillon Beach by *Ammophila* in the foredune. They occur instead primarily in the interior mobile dunes where *Ammophila* is currently scarce.

The outer foredune ridge is the only one with consistent active sand deposition; the dense *Ammophila* cover traps nearly all sand in this zone (Figures 3, 4). Some blowouts (gaps in vegetation undergoing active wind-erosion and dune movement) occur, primarily at the south end of the foredunes, in association with current or former footpaths. The foredune is variable in height, but ranges between approximately 3 to 5 m above the backshore at its toe. The foredune crest is relatively linear, sculpted by former wave-eroded, linear scarps that have regenerated vegetation and sand accretion following storms. The crest zone is hummocky, with large sand-shadows (zones of concentrated sand deposition behind obstacles) that at least temporarily inundate the *Ammophila*, burying its erect leaf canopy. I subjectively estimate annual local rates of sand accretion between 0.3 and1.2 m (possibly 1.5 m) of sand per year in the foreslope and crest zones of the foredunes. In recent years, most backslope (east-facing) areas of the outer foredune have been stable.

The interior relict foredune zone is largely stabilized, and has developed some native and non-native dune scrub vegetation associated with older, stable interior dunes to the east (Figure 4). It is punctuated in a few areas by blowouts (unvegetated, mobile dune lobes with erosional throats) associated with past trampled vegetation of pedestrian trails. Substantial cover by living *Ammophila* and its persistent leaf litter dominates the surface of the stable relict foredunes, and shrubs and forbs are widespread. The height and topographic relief of the relict foredunes are greater than those of the foredunes, suggesting either reworking by wind (blowouts, growth followed by stabilization), or longer duration of former foredune position. The great width of the relict foredune zone (several hundred meters, variable) is consistent with past long-term beach progradation (building seaward), which is exceptional in California. Most foredunes in central California exhibit indications of recurrent scarping and retreat. The foredunes appear to be prograding today mostly at the south end, near Sand Point (where embryo foredunes and foredune accretion are best developed); the northern segment (Dillon Beach) appears to be either stable or retreating.

3.3. **Dune slacks** (syn. deflation plains, dune hollows, dune swales). As Cooper (1967) observed, the stabilization of the foredunes by *Ammophila* either caused, or amplified, the development of a wide dune deflation (wind erosion) zone downwind, forming extensive sand-starved dune slacks (flats eroded to near the water table, forming wetlands; Figures 5, 7) east of the stabilized foredune zone. The extensive western dune slacks were used for cattle grazing in Cooper's era, and are currently used for mixed cattle grazing and recreation. They also support extensive coastal wetlands (Fig. 5). The dune slacks occupy a significant

portion of the younger dune sheet (the portion west of Brazil Beach, Tomales Bay), and are most extensive near Sand Point.

The large southern dune slack is a continuous plain with little topographic relief other than the artificial drainage ditch. It is heavily used by cattle, and contains a mixture of native marsh and non-native pasture grasses adapted to seasonal wetland conditions. The northern and especially northwestern dune slacks are discontinuous and irregular, separated by irregular U-dune remnants (mostly flanks). The northern dune slacks contain mostly native marsh vegetation, including some highly distinctive associations and regionally rare species. They also contain the most topographic relief, including perennial ponds up to approximately 1.5 m deep when flooded, drawing down with gradually declining groundwater seasonally in late summer. In some years, the ponds remain flooded year-round in deepest areas.

3.4. **Interior mobile transverse dunes and slacks**. The large, mobile dunes of the Tomales Dunes system consist of a geologically young sheet of transverse dunes in stages of degeneration (Figure 6). Transverse dunes resemble giant sand ripples, with irregular crests perpendicular to the dominant northwest winds. The transverse dune form is at Tomales Dunes appears to be degenerating as a result of (a) colonization by *Ammophila* at the extreme west and east ends, causing it to break up into stabilized ridges and hummocks, or U-dunes; and (b) net loss of sand volume due to sand mining, reducing the steep-backed, sharp-crested, high transverse ridges to lower, broad, convex sheets with poor definition (except at the quarry edge). The transverse dunes formerly represented a series of continuous "waves" of sand blown landward from the beach. The historic development of vegetated *Ammophila* foredunes has severed them from both replenishment and continuity with the backshore sand source. Invasion of transverse dunes by *Ammophila* initially causes them to develop vegetated dune hummocks, and later U-dunes in various degrees of stabilization. Overall, the transverse dune pattern appears to have decayed in the last decade.

The transverse dune ridges, and incipient U-dunes, themselves act as obstacles to sand transport where they form high slip-faces (steep backslopes at the angle of repose for dry sand) that trap most blown sand in their sheltered lee. The migrating slipface overrides deflation zones caused by the sand-starvation that the slipface induces. The dune migration is associated in most areas by a corresponding formation and migration of dune slack.

The lowest dune slack elevations vary with depth to the capillary fringe of the water table at the time of active sand erosion (deflation) by wind. Sand is effectively immobilized by capillary forces associated with saturated sand or very moist sand. In winter, or summers following very high rainfall, the water table surface is relatively high; in summer and especially in drought years, the "base level" for potential dune erosion is very low. As the dune slack edge migrates over a water table that fluctuates seasonally or among years, it leaves traces of alternating linear marsh depressions (swales), higher-relief marsh, or even relict low dune ridges, parallel with the margin of vegetated slack and unvegetated dune slope. Some ridges, temporarily stable in position, accumulate significant dune sand and support lines of transitional terrestrial vegetation or actual dune vegetation. These "counter-ridges", or Gegenwälle (original German name in older dune physiographic literature; Paul 1944), are scarcely developed along most of the central coast, but are associated with Pacific

Northwest dunes. Tomales Dunes have supported the most differentiated counter-ridge patterns of dune and slack (Figure 5) in the central coast region between San Luis Obispo and Humboldt Bay.

In contrast, where the dune slack is eroded to the greatest depth by wind deflation prior to vegetation establishment, it forms seasonal ponds when water table elevations rebound in winters or wet years. Although the entire slack may become temporarily flooded during series of intense winter Pacific storms, seasonal and effectively perennial ponds within slacks are local and few, forming mostly in the northwestern portion of the dune system. The natural perennial ponds are generally elongated and aligned with northwest winds, and are dozens of meters long or more, but usually less than 5 – 6 m wide in spring (Figure 7).

The dune slacks at the southwest and northwest ends of the dune systems are stable, owing to the upwind influence of closed, stable *Ammophila* vegetation. The dune slacks at the eastern end of the younger dune sheet are unstable, subject to either net growth (north end), or net infilling with mobile sand upwind (south end). The loss of slip-face dune form, and its replacement with convex, shallow "lapping" dunes, is associated with rapid transgression of mobile dunes over dune slacks. The shift from slipface to "lapping" dune form has been conspicuous in recent years at the south end of the Tomales Dunes. It appears to be associated with some upwind stabilization by *Ammophila*, which prevents large volumes of sand from being transported to the crest, and maintaining dune height and steepness during migration. Sand mining appears to have similar downwind effects

3.5. **Climbing dunes.** Much of the northern and eastern portions of the Tomales Dunes complex consists of climbing dunes with hummocky, irregular topography or U-dunes, formed by past migration over older marine terrace soils or Franciscan formation soils (Figure 8). Woody vegetation colonizes and dominated central California coastal dunes after they become fully stabilized by vegetation. The younger, western dune sheet (associated with Dillon Beach/Lawson's Landing area) has significant areas of dune scrub, primarily associated with the northern edge of the dune sheet, where it grades into older terrestrial soils, or overrides older dune soils (paleodunes). Other, younger dune scrub is developing on *Ammophila*-stabilized relict foredunes and some U-dune flanks in the central dune area. Much older dune scrub is associated with the climbing U-dunes (paleodunes, possibly late Pleistocene age) north of Brazil Beach and Toms Point (unavailable for survey; no public access; Figure 12). The exceptional elevation of the climbing dunes (up to 120 m before 1967; Cooper 1967) is largely due to the high base elevation of the dunes, not the actual thickness of the dune deposits.

Erosion of some stabilized climbing dunes (scarp exposures of the large spring and dune canyon 1997-2002; see below) has exposed at least two buried former dune scrub soil horizons, indicating multiple episodes of dune deposition, long-term stabilization associated with soil formation, and burial by mobile dunes. Such cycles demonstrate prehistoric, periodic rejuvenation and re-formation of stable dune scrub within at least portions of the younger dune sheet.

One conspicuous, outstanding climbing dune feature is an isolated bedrock outcrop, about 40 m in elevation, mantled by unvegetated sand on most of its west face, and sparse dune

scrub on its south, east, and north slopes. It is located southeast of the Lawson Landing campground entry gates, where it appears as the high point of the dune horizon. The crest is variably shallowly buried or scoured free of sand. The feature appears to be an anomalously large isolated dune in fixed position (Figure 9). Cooper (1967) interpreted the hill to be an ancient sea stack, associated with a former marine terrace, mostly overridden by a transverse dune ridge.

3.6 **Dune-dammed ponds**. Large migrating climbing dunes can obstruct seasonal drainages, impounding hillslope runoff or streamflows in gulches or ravines, thus forming wetlands or ponds. The climbing dunes of the outer, younger dune sheet have long ago formed a large dune-dammed pond (Cooper 1967; Figures 1, 2, 10). Smaller, ephemeral dune-dammed ponds occur below emergent dune springs and ephemeral streams in the dunes along the northern edge of the climbing dunes (Figures 4, 11). One dune-dammed stream channel forms a smaller perennial to seasonal pond below a broad spring (pasture and marsh grass, bulrush, stinging-nettle "oasis" in dune scrub) located between the entrance kiosk at Lawsons Landing gate and the quarry road. Dune-dammed ponds are distinct from the seasonal ponds in dune slacks near sea level, which are associated with groundwater elevation fluctuations in thick dune sand and marine sand deposits near sea level.

3.8 **Large dune spring and canyon**. An exceptionally productive, perennial spring emerges in the climbing dunes southeast of the isolated bedrock outcrop/climbing dune feature (Figure 11). The spring occurs along a contact surface between the younger dune sheet and the less permeable underlying terrestrial soils (probably raised marine formations), which appear to function as an aquaclude (barrier to infiltration). The spring may be related in part to dune-damming (sand infilling and impeded drainage) of small streams in gulches draining the adjacent hillslopes, and local groundwater discharge. The spring is reduced to a mere summer seep and wetland "oasis" within the xeric dune vegetation in years of low rainfall. It generally flows to some extent throughout the summer. In years of high rainfall, it becomes a perennial spring with very high peak discharge in winter and spring months, when the spring surface (up to 4 – 5 m wide) is a roiling, turbulent water surface. The seasonal stream formed by the spring saturates the sand below it, eroding a wide, braided sand-bedded channel (with silt and angular pebbles, gravels) up to approximately 20 m wide.

In 1997-1998, the spring-fed stream eroded a continuous channel through the dunes to Brazil Beach (Tomales Bay) where it terminated in an alluvial fan composed of dune sand with traces of terrestrial soil and pebbles. The high dune scarps eroded by the spring-fed stream form a "dune canyon", and have exposed buried relict dune soil horizons of former stabilized dune surfaces. Deflated remnants of the channel are still evident in the alluvial fan at Brazil Beach, and deflation lags between dunes that have encroached the relict flood channel. The seasonally moist bed provided a "nursery" for *Ammophila* fragments and seedlings in less energetic subsequent years. The active stream now terminates approximately 200 m (channel length) below the spring, where ephemeral dune-dammed ponds infiltrate into dune groundwater. These are now becoming obscured by vegetation.The lower reaches of the relict channel now sustain only subsurface flows, and have been encroached by *Ammophila* dune hummocks 2 – 3 m in height above the bed. The subsurface flow of the relic channel is still expressed in the alluvial fan along Brazil Beach, where freshwater and

fresh-brackish marshes fringe the otherwise saline shoreline, and where intertidal sandy shoreline seeps are fresh-brackish.

3.9 **Paleodunes** (ancient U-dunes): Southeast of the dune scrub of the climbing dunes at Lawson's Landing, and north of Brazil Beach to Tom's Point, is an extensive set of much older (likely late Pleistocene) U-dunes and deflated dune surfaces. The U-dune topography remnants are not highly conspicuous from the perspective of publicly accessible dune peaks in the public Lawson Landing recreational areas above Brazil Beach (Figure 12): the dunes are mostly obscured by coastal scrub vegetation, and some blue gum (eucalyptus) stands. The ancient U-dunes consist mostly of nearly parallel ridges (linear dunes) and troughs aligned with dominant NW winds. A few blowouts in the older dunes, revealing weathered yellow-brownish (iron oxide-stained sands) are still evident. Cooper (1967) reports that the paleodune deposits here are generally thin, with exposures of bedrock, and lag deposits of coarse particles.

4.0 Vegetation and plant communities of Tomales Dunes

4.1 Flora of Tomales Dunes

Geographic survey areas and dune habitats.

The local Tomales Dunes flora is incompletely surveyed. Approximately half the dune complex consists of the eastern paleodunes northeast of Tom's Point(ancient U-dunes, possibly Pleistocene age) on multiple privately owned parcels. A related portion of the ancient dunes occurs on the northwest shore of Tom's Point below the small unnamed stream. Other than this conservation land (Cypress Grove, Audubon Canyon Ranch), much of the eastern dune sheet is not currently available for surveys. Portions of the coastal scrub on the unsurveyed eastern paleodunes appear to be represented by vegetation stands on the accessible Lawson's Landing area, but large areas of apparently distinct vegetation types (including mesic scrub with apparent seasonal stream influence, indicated by relatively high frequency of cow-parsnip (*Heracleum lanatum*), lizard-tail (*Eriophyllum stoechadifolium*), and other species very infrequent on the Lawson Landing stable dunes) also occur. The known partial flora of Tomales Dunes is therefore largely restricted to the much younger portion of the dune sheet at Lawson's Landing.

Past botanical surveys in the Lawson's Landing dunes are not consistent in geographic or ecological scope. Recent surveys by Monk and Associates (1999) were limited to the sand quarry areas. The extensive and precise unpublished vascular species list for the "Dillon Beach Area" prepared by Doreen Smith (1998, San Rafael, CA) combined original surveys by Smith, and "all previous lists combined", citing Wilma Follette, Robert West (local botanists), and J. T. Howell (Howell 1970). The "Dillon Beach Area", however, includes species-rich coastal grassland and scrub on much older marine terrace and Franciscan formation soils that lie well outside the Tomales Dunes sheets, and are not appropriate to combine with an ecologically-based Tomales Dune flora. Review of the Smith list confirms many species that are not found in coastal dunes, ancient or recent. A similar problem occurs with locality descriptions of "Dillon Beach" without specific

reference to dunes, as in some taxa reported by Howell (1970). Some of these ambiguous geographic/habitat descriptions can be resolved by recent observations of confirmed taxa.

It is also difficult to distinguish between some recent and historic records in the local Tomales Dunes flora, owing to some uncertainty regarding the status of possibly or presumably extirpated species. For example, Howell (1970) reported beach silver-top, *Glehnia littoralis* ssp. *leiocarpa* (as *Cymopteris leiocarpa*, a synonym) in his 1949 Marin Flora, the southern limit of the subspecies, but there are no recent records of this taxon in Marin County; it may be presumed extirpated at Dillon Beach (the reported Howell locality), given its typical unstable beach-foredune habitat and modern prevalence of *Ammophila*. With other older reports of infrequent to rare plant taxa, there is often much greater uncertainty regarding their current population status in the Tomales Dunes.

Important evidence regarding California coastal plant migrations over geologic time lies in the patterns of distribution, and gaps in distribution, of coastal dune plant species; the presence and absence of species among Tomales Dunes and other dune systems in the region. In addition, the isolated local Tomales Dunes populations of these species contain genetic information that is likely to be significant for future research in their population structure and ancestry. These data may enable past migration patterns of California coastal vegetation over geologic time to be reconstructed. Local extirpation of plant populations at Tomales Dunes due to direct or indirect effects of land use changes may permanently erase opportunities to recover important genetic information.

Distinctive aspects of the Tomales Dunes flora.

There are numerous examples of anomalous, distinctive, unique, or otherwise biogeographically significant distributions of plant taxa at Tomales Dunes, compared with the adjacent Point Reyes dunes, Bodega Head dunes, and other dune systems of the central and northern California coast. Plant rarity and legal protection status is considered separately from this aspect of biogeographic significance.

Some wide-ranging, common elements of coastal dune scrub are conspicuously absent or rare at Tomales Dunes. Chamisso's or silver dune lupine (*Lupinus chamissonis*), the native shrub lupine of central coast dunes, is either absent or very rare at Tomales Dunes. It was reported at Dillon Beach by Cooper (1967), and recently by Monk and Associates (1997), but all specimens I have examined are a highly silky-silvery pubescent form of yellow bush lupine (*Lupinus arboreus*), a native California state species that is doubtfully or exceptionally native to coastal dune plant communities (Cooper 1936, and Appendix 2, this report). *L. arboreus* was historically seeded into California dunes following *Ammophila* plantings to stabilize them (McLaren 1924). The superficial resemblance of this highly silvery-silky biotype of yellow bush lupine to Chamisso's dune lupine may be the basis for misidentification of plants in their vegetative state.

Coast buckwheat (*Eriogonum latifolium*), a subshrub quite common on coastal bluffs and stable dune vegetation in Marin County and most of the California coast, is also absent or very rare in Tomales Dunes. A coastal dune bluegrass. *Poa douglasii*, is common and widespread in Point Reyes dunes and most central coast dunes. It was reported by Smith (1998), but is

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apparently either locally rare or naturally absent in Tomales Dunes. (I found a small, young population of *P. douglasii* was in dune soils at a residence of Lawson's Landing, possibly a nursery transplant.) Similarly, dune sage (*Artemisia pycnocephala*), a widespread and common species typical of early successional stages of dune stabilization at Point Reyes (and most of the central and northern California coast's larger dune systems) though reported by Smith for the Dillon Beach area as a whole, is scarce or absent in the Tomales Dunes vegetation. Both dune wallflowers of this region, *Erysimum franciscanum* and *E. menziesii* ssp. *concinnum*, are also absent at Tomales Dunes, but present (though uncommon) north and south of it. The low succulent herb, live-forever or bluff-lettuce (*Dudleya farinosa*) a widespread and common species typical of both coastal bluffs and gaps in old dune scrub of the central California coast, is absent or undetected at Tomales Dunes.

Tidestrom's lupine (*Lupinus tidestromii*), a rare endemic low-growing perennial forb federally listed as endangered (Figure 13) was reported from Dillon Beach in grazed deflation dunes near the campground entry gate in the early to mid-1990s (Monk and Associates 1999, U.S. Fish and Wildlife Service 1998). No voucher specimen was collected to verify its identification before the population was extirpated. If this is indeed a genuine natural locality of this species, it would be the only one outside of the three known historic disjunct population centers at Russian River dunes, Point Reyes dunes (the largest population), and the Spanish Bay (Pebble Beach) dunes of the Monterey peninsula.

Another perennial dune forb with a highly discontinuous distribution in southern portions of its range, dune tansy (*Tanacetum camphoratum*), occurs locally in Tomales Dunes, but is otherwise absent between San Francisco (southern limit) and the central Mendocino County coast. It is extinct at the historic Rodeo Lagoon locality, and it has never been reported from Point Reyes. The Tomales Bay phenotypes are quite distinct from the San Francisco population, and are intermediate with those of Humboldt County coast northward. Most of the San Francisco populations are managed or restored, so the Tomales Dunes populations of *T. camphoratum* represent the largest wild populations in the southern end of its range. The southern populations were formerly treated as a distinct, rare species, and may be restored if comprehensive sampling and contemporary methods are used to revise the genus.

Of the annual native dune forbs species with relatively narrow distribution, only a few found in Point Reyes dunes have been reported in Tomales Dunes. Both forms of San Francisco spineflower, (*Chorizanthe cuspidata*, Fig. 14), formerly recognized as taxonomically varieties (vars. *villosa*, *cuspidata*), occur together in mixed populations at Tomales Dunes, near the northern historic limit (where only var. *villosa* occurred) at Horseshoe Cove, Sonoma County (Salt Point State Park; Best *et al.* 1996).

In contrast, some annual forbs such as coast or broadleaf purple owl's-clover (*Castilleja exserta* ssp. *latifolia*) and dune coyote-mint (*Monardella undulata*), both local at Point Reyes dunes, and historically known mostly from there, San Francisco, and Monterey dunes) are apparently absent in the local Tomales Dunes flora. Neither subspecies of dune gilia (*Gilia capitata* ssp. *chamissonis*, ssp. *pacifica* have been observed or reported from Dillon Beach by Howell (1949), and I have been unable to locate them. *G. capitata* ssp. *chamissonis* has s been reported from the Dillon Beach area by Smith (1998). If it is indeed absent in dunes

here (it is at least very uncommon), this would be a large gap in its distribution from San Francisco to Salmon Creek (N end Bodega Head dunes). The regionally rare annual large-flowered linanthus (*Linanthus grandiflora*), and the globally rare and endangered Sonoma spineflower (*Chorizanthe valida*), both locally abundant in old dune grassland at Point Reyes, are absent in Tomales Dunes, despite abundant suitable habitat.

Other missing perennial dune forbs species anomalously "missing" at Tomales Dunes, expected based on regional distribution or frequency in Point Reyes dunes, include western or cobweb thistle (*Cirsium occidentale*), coast paintbrush (*Castilleja wightii* and *C. affinis*. Tomales Dunes has suitable habitat within geographic ranges of some rare plants native to dunes and slacks of Point Reyes dunes, but have either not historically occurred naturally at Tomales Dunes, or became naturally extinct there before discovery: These include Marin horkelia (*Horkelia marinensis*), beach layia (*Layia carnosa*), and Franciscan thistle (*Cirsium andrewsii*).

As described in Appendix 2, unique putative intermediate or hybrid plant complexes occur at Tomales Dunes, some with no clear taxonomic status. A form of wildrye (*Leymus*) intermediate in many traits of Vancouver wildrye (*L.* x*vancouveriensis*) and Pacific wildrye (*L. pacificus*) or the base species *L. mollis, L. triticoides, L. pacificus*) may be endemic to this dune system (Fig. 15). The taxonomic status of this anomalous endemic population is unclear. The very uncommon *Leymus pacificus* (Pacific wildrye; Fig. 16) does occur as either a pure species, or intermediate with the widespread *L. triticoides*, in a cluster of small populations at Tomales Dunes near the dune spring. A local population of a dwarfish *Equisetum* (horsetail), exhibiting affinities with *E. laevigatum* and *E.* x*ferrissii*, occurs extensively in one dune slack at Tomales Dunes (Fig. 17). No comparable *Equisetum* populations are reported from other coastal dunes of this region.

The dune slack ponds of Tomales Dunes support exceptional populations of wetland and submerged aquatic plant species seldom found in coastal dunes. Extensive stands of western Lilaeopsis (*Lilaeopsis occidentalis*; Fig. 18) occur in Tomales Dunes slacks. This species normally is otherwise found only occasionally, and in small colonies, on fluctuating shorelines of intermittently tidal or fully tidal coastal lagoons north of San Francisco. Some of the largest populations of *L. occidentalis* in the eastern dune slacks have undergone recent (2003-2004) rapid burial by dune transgression. The only reported populations of *Triglochin striata* (a diminutive species of sea-arrowgrass normally found only in fresh-brackish estuaries and river mouths in California) in Marin County (Howell 1949, 1970) occurs in exposed beds of at least two perennial ponds in northwestern dune slacks.

An unidentified species of *Chara* (stonewort or muskgrass, Fig. 19; a remarkable non-marine algal genus that structurally resembles a submerged vascular plant like *Najas*, and depends on abundant dissolved calcium and non-acidic water) is seasonally abundant in deeper dune ponds of Tomales Dunes. *Chara* is generally not reported from coastal lagoons or dune ponds in California, where lagoons usually are either saline or brackish (sodium-rich, subject to dominance by *Ruppia*, wigeongrass) and dune ponds are normally acidic to highly acidic. Some species of *Chara* are common in ricefields and irrigation ditches of the Central Valley, but the identity of this coastal *Chara* is not currently known. Several listed rare endemic coastal species of *Chara* occur in Britain and Europe, but there are no modern

studies of the genus on the California coast. Also rare in coastal dune slacks are native pondweeds: two are locally abundant in Tomales Dunes ponds, *Potamogeton foliosus*, and *P. nodosus* (Fig. 20). These two pondweed taxa themselves are widespread, but uncommon in California.

The apparent gaps in distributions of some Point Reyes or central coast dune plants at Tomales Dunes may be either natural (related to unpredictable prehistoric patterns of plant dispersal and migrations, or physical events in Tomales Dunes), or they may be artificial and historic. The inherently large proportion of the dunes with history of extreme instability at Tomales Dunes may be responsible for some species gaps. Point Reyes and San Francisco dunes, larger systems with more refuges in older, stable dunes, may have been able to avoid outright extinctions by virtue of size and chance. It is noteworthy that many of the rare plant species at these dune systems occupy relatively few, local areas.

Rare, special-status, or listed endangered plants at Tomales Dunes.

In addition to plant populations with biological significance (taxonomic, biogeographic, biological conservation), there are also listed rare plants at Tomales Dunes, some with protected legal status (state or federally listed species under endangered species laws) or institutional recognition of conservation priority (e.g. CNPS rare plant inventory list, CEQA status).

Northern salt marsh bird's-beak (*Cordylanthus maritimus* ssp. *palustris*, Fig. 22) has been surveyed at the Brazil Beach bayshore sandy tidal marshes (salt marsh and brackish seep marshes at the toe of the dunes) since at least 1991 (Grant Fletcher, Sonoma, CA; unpublished data, 1991-2000; CNDDB 2000). Individual colonies of *C. maritimus* here are subject to extirpation by cattle trampling and other habitat factors (changes in marsh drainage, salinity, sediment accretion, competition), but the larger population is likely to persist. In 2004, the population in the pocket Brazil Beach salt marsh surged, becoming co-dominant with saltgrass and creeping sea-arrowgrass over an area nearly one quarter acre, composed of tends of thousands of flowering and seed-bearing plants. The dramatic increase in its extent and abundance after many years of scarcity suggests the presence of dormant seed banks that emerge intermittently. The current population surge and high seed production is likely to "recharge" the persistent seedbank. The subspecies is widely distributed but often uncommon in Tomales Bay salt marshes. It is locally and intermittently abundant at some localities, such as Walker Creek delta marsh.

Lupinus tidestromii (Tidestrom's lupine, a federally listed endangered plant; Fig. 13) was reported by Dianne Lake of WESCO in 1990 surveys, but has not been observed in the last decade. If the identification of this species was correct, it may still be part of the local flora, because it is likely to support a long-lived persistent seed bank.

Other special-status rare plants are reported from *near* Tomales Dunes (Dillon Beach area), but have not been verified to occur specifically on dune substrates. These include northcoast phacelia (*Phacelia insularis* ssp. *continentis*), and Blasdale's bentgrass (*Agrostis blasdalei*). Focused searches for these species are needed to determine locations of populations in relation to the dune sheet. Some rare plants of the Point Reyes peninsula, or

other north coast localities, appear on "potentially occurring" checklists for Tomales Dunes, but are either not known to occur there, or are artifacts or errors of databases organized by USGS quad sheets (geographically or ecologically unlikely at Tomales Dunes localities); these include: Pt. Reyes blennosperma (*Blennosperma nanum* var. *robustum*), swamp harebell (*Campanula californica*), Mt. Vision ceanothus (*Ceanothus gloriosus*), Sonoma spineflower (*Chorizanthe valida*), Raiche's red ribbons (*Clarkia concinna* ssp. *raichei*). The federally endangered showy Indian-clover (*Trifolium amoenum*) does not occur in the Tomales Dunes system, but is native to the older grassland soils of the marine terrace; it is not expected to occur in dry stable dunes, but could potentially occur in grassland of seasonally moist but non-wetland dune slacks. The rare coastal rock morning-glory, *Calystegia purpurata* var. *saxicola*, is also reported from the area by Smith (1998), but has not been verified on the dunes themselves. It is not expected to occur on thick dune deposits, based on its distribution and rocky coastal habitats in northern Sonoma and southern Mendocino Counties, the core of its range. It may possibly occur along the thin edges of the Tomales dune sheet, or in deflation zones of the paleodune sheet.

4.2 Plant communities and vegetation of Tomales Dunes

Tomales Dunes contain a wide range of coastal dune and dune slack (wetland) plant communities, some of which are highly distinct from their closest comparable types at Point Reyes dunes and Bodega Head dunes. The vegetation includes most elements typical of Point Reyes dunes, but with contrasting composition of plant communities. These basic vegetation types at Tomales Dunes include:

(a) European beachgrass (*Ammophila arenaria*)-dominated foredune and stable backdune grassland, mixed with yellow bush lupine (*Lupinus arboreus*) – Fig. 2;

(b) transitional decadent *Ammophila* and native dune scrub in stabilized, older, landward *Ammophila* dunes (forb understory, shrub layer dominated by coyote-brush, *Baccharis pilularis* and mock-heather, *Ericameria ericoides*) – Fig. 2;

(c) native pioneer mobile dune forbland (dominated by prostrate beach-bur, *Ambrosia chamissonis*, and yellow sand-verbena, *Abronia latifolia*, and dune rush, *Juncus lescurii* (cf. *J. breweri*) in sparsely vegetated mobile dunes locally free of *Ammophila*) – Fig. 21;

(d) stabilized dune scrub dominated by yellow bush lupine, *Lupinus arboreus*, and mock-heather, *Ericameria ericoides*, with a rich and variable ground layer of annual and perennial forbs (both native and non-native), locally abundant tall native perennial forbs, and widespread non-native annual grasses, producing a nearly closed (gap-free) vegetation – Fig 8;

(e) dune slacks with variable grassland and coastal marsh vegetation, with dominants including *Juncus lescurii*, *Scirpus pungens, Eleocharis macrostachya, Potentilla anserina, Trifolium wormskioldii, Distichlis spicata*, and an *Equisetum* (undetermined taxon with mixed traits of *E. laevigatum* and *E.* x*ferrisii* – Fig.);

(f) rare dune slacks with deeply flooded, base-rich (calcareous) seasonal ponds/seasonal marshes, dominated by perennial and annual submerged aquatic vegetation in submersed phases, including two regionally uncommon native pondweed species (*Potamogeton foliosus, P. nodosus*) and a macroalga (*Chara* sp.), and dominated by graminoid marsh vegetation (*Eleocharis macrostachya, Scirpus pungens, Lilaeopsis occidentalis)* in emergent phases – Fig. 7;

(g) small inclusions of willow riparian thickets (*Salix sitchensis, S. lasiolepis*) in dune slacks with little cattle grazing;

(h) fringing shoreline tidal salt marsh vegetation with variable salinity (fresh-brackish seeps to hypersaline pans) and highly variable dominants, ranging from seasonal hypersaline wigeongrass pans (*Ruppia maritima*), saltgrass/pickleweed marsh (*Distichlis spicata, Salicornia virginica*), diverse salt marsh forbs (*Triglochin concinna, Cordylanthus maritimus, Spergularia* spp.) to variable brackish marsh assemblages of saltgrass/salt rush/jaumea/silverweed/bulrush and clover (*Distichlis spicata/Juncus lescurii/Jaumea carnosa/Potentilla anserina/Scirpus pungens* and *Trifolium wormskioldii*)

In addition, other diverse coastal scrub vegetation types occur on the older, eastern paleodune sheet beyond the accessible survey area, on privately owned parcels with no public access. The structure and composition of the paleodune coastal scrub is therefore not reported here, but it appears to include a much larger proportion of coastal scrub elements from the older soils of the adjacent marine terrace, including mesic elements associated with seeps and surface drainages.

The primary distinguishing features of Tomales Dunes vegetation include:

(a) the very high proportion and extent of dune slack wetlands, including base-rich (calcium carbonate-enriched) marshes and ponds;

(b) the very high proportion of naturally mobile, unvegetated or sparsely vegetated high-relief dunes still uncolonized by *Ammophila*;

(c) the largest continuous expanse of native scrub vegetation on paleodunes (possibly Pleistocene age) in California north of Monterey Bay;

(d) the northernmost stands of extensive, continuous, and still-expanding dune scrub dominated by mock-heather, *Ericameria ericoides*. Mock-heather is the characteristic and dominant coastal dune scrub plant species of the entire central California coast, and Tomales Dunes represents the northern limit of its full development.

As explained in the discussion of Tomales Dunes floristics, there are numerous gaps in the distribution of some dominant, common, and uncommon plant species in the plant communities of Tomales Dunes. The characteristic dune scrub native *Lupinus chamissonis* is effectively replaced here as a dominant by an atypical silvery-silky pubescent form of the historically non-dune yellow bush lupine, *Lupinus arboreus*. Despite an abundance of early-stabilization phases of dune forbland and scrub, the normally dominant dune sage (*Artemisia*

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pycnocephala) does not form a plant community here. The normally rare grass *Leymus pacificus*, though only locally distributed here, is more abundant and extensive (as are some putative hybrids) than the typical stable dune grassland dominant, *Poa douglasii*, which is absent over most of the stable dune area.

4.3 Rare plant recovery and conservation potential in Tomales Dunes

Despite the wealth of native dune plant species and their habitats, Tomales Dunes in their current condition are subject to progressive and potentially irreversible degradation of its dune vegetation. The unchecked spread of *Ammophila* into the mobile dunes, spread of invasive *Conicosia pugioniformis* (annual iceplant), and aggressive invasion and excessive dominance by yellow bush-lupine are likely to facilitate further wildland weed problems, such as dominance by annual non-native grasses, and reduce conservation potential for existing sensitive plant populations. Local and unique plant populations, including the anomalous intermediate *Leymus* (*L. pacificus*-x*vancouveriensis*) complex, the intermediate *Equisetum* (*cf. E.* x*ferrisii*), the *Chorizanthe cuspidata* complex, and extensive stands of *Lilaeopsis occidentalis* are at risk of significant decline or local extinction if these invasions proceed and stabilize the dunes unnaturally in coming decades.

The Tomales Dunes also have potential for recovery of endangered and other sensitive plant species if they are managed to preclude degradation by non-native plant invasions or artificial stabilization. The paleodunes may have potential for establishing a population of the endangered Sonoma spineflower, *Chorizanthe valida*, now reduced to paleodune grassland of Point Reyes. Establishment of a second population in its native range, but with an independent risk of extinction, may contribute to the recovery of this species. Similarly, endangered *Lupinus tidestromii* and *Layia carnosa* are clearly within historic ranges at Tomales Dunes, and have abundant suitable habitat there in current (or improved) conditions. Tomales Dunes remains one of the only unoccupied suitable off-site areas for establishment of new conservation populations.

5.0 Insects of Tomales Dunes

(section contributed by David Wright, Ph.D.)

5.1. The Dune Insect Community

Unusual soil and vegetation conditions tend to foster unique communities and species of insects. Insects are capable of a high degree of habitat specialization and their populations may be restricted to – yet persist on – small patches of habitat (relative to vertebrates). As a result, over time, endemic subspecies or species (found nowhere else) may evolve.

Dunes present unusual ecological challenges to insect species, and have been recognized as supporting distinctive communities of insect species. Coastal dunes are attractive to people and are subject to considerable development or disturbance in California (Powell 1981).

The Tomales dunes are an unusual habitat in that they constitute a sizeable pocket of highly active maritime dunes, enclosed by narrower shore zones and upland coastal prairie. The nearest dune habitats of comparable extent are on Point Reyes and Bodega Head, several

miles away and outside the flight distance of many insects. Further, certain dune insects are flightless. The low likelihood of genetic exchange between the nearest population areas enhances the likelihood of development of local endemics, and the distinctive environment of the dunes means that many species found there do not extend into the more common adjacent habitats.

To our knowledge, no dedicated study of the insect fauna of the Tomales dunes has yet been made, nor has there been any broad survey for species or subspecies endemic to the dunes other than a few specific target species. A systematic insect survey of the Tomales dunes would be worthwhile. The site is rich in native bee species (Hymenoptera: Apoidea), and in particular has good habitat opportunities for ground-nesting native bees (e.g., certain andrenids, colletids, halictids, anthophorines, and bumblebees). Other ground-nesting insects find similar opportunity in areas of consolidated sands on the site. One example is the sand wasp, *Bembix* sp. (Hymenoptera: Sphecidae). This bee-like and not-very-aggressive wasp nests singly but in sizeable aggregations in locations that are used year after year. Sand-loving beetles (e.g., certain carabids, tenebrionids, scarabs, etc.) are common on the site. The presence of dune specialist insects in other insect orders also is to be expected.

The dunes area encompasses some more widespread habitat types, notably numerous seasonal wetlands. Insect species that use these wetlands are likely to be found at similar wetlands outside the dune area, but because of widespread impacts to wetlands and their limited availability in California, wetland insect communities also often have unusual or threatened species. Duration of inundation is an important factor to aquatic insects and other animals inhabiting these wetlands. The deeper, longer-lasting pools support damselflies and dragonflies (Odonata) as well as numerous other aquatic insects. Shallower pools lack the large odonates but have fly (Diptera) species, water striders (Hemiptera: Gerridae) and diving beetles (Coleoptera: Dytiscidae), for example. How long a pool lasts is affected by many factors including its depth, size, and – particularly in well-drained dune soils -- topographic position and groundwater level. Alterations in groundwater levels or flow may affect seasonal wetland communities. Some insects also use the moist margins of seasonal wetlands. The Oregon tiger beetle, *Cicindela oregona oregona*, is common around seasonal wetlands on the site and on the moist sands that remain after a pool has disappeared, as well as along the beach and mudflats along Tomales Bay.

The dune habitats of the Tomales dunes are invaded by non-native plants that continue to spread, particularly European beachgrass (*Ammophila arenaria*) that stabilizes mobile dunes. Many specialized dune insects are adapted to loose and mobile sands and the high solar exposure that accompanies bare sands. Stabilization of sands and increased cover alters what insects can live there, and dune specialists may die out or be pushed out.

5.2. Special-Status Insects and Other Arthropods

Both species known to occur at the Tomales dunes and species that may occur but have not been adequately surveyed for are discussed below. For potentially occurring species, a rough assessment of likelihood of occurrence is given. Insects may be listed as threatened or endangered under the federal Endangered Species Act but not under the California

Endangered Species Act. However, the considerations given to rare species under the California Environmental Quality Act (CEQA) apply to insects.

> **Myrtle's silverspot butterfly (*Speyeria zerene myrtleae*)** – federally listed Endangered in 1992; recovery plan 1998 (USFWS 1998; online at http://endangered.fws.gov/recovery/#plans).

This attractive butterfly may be present on the site. There is an unconfirmed report of the species from the summer of 2003, in the vicinity of the sand quarry. This report needs to be confirmed.

I observed Myrtle's silverspots just north of Dillon Beach in July, 2003. Roughly two dozen adults were nectaring on bull thistles (*Cirsium vulgare*) near the intersection of Lelani Lane and Oceana Drive. This location is 2 kilometers (km) north of the Tomales dunes.

Myrtle's silverspots are also known from coastal prairie north and south of the Estero de San Antonio, about 3 km north of the dunes, and from Point Reyes peninsula, including part of the northern point directly across Tomales Bay from the Tomales dunes. The Tomales Point population is about 2 km south-southwest of the Tomales dunes.

Myrtle's silverspots are strong flyers and movements of several kilometers are quite possible. The butterflies are capable of moving widely in search of nectar, host plants, or mates (USFWS 1998).

The larval food plant of the Myrtle's silverspot is *Viola adunca*, and possibly other violets. Violets presently do not appear common in the dunes, but may occur in nearby coastal prairie - e.g., above coastal bluffs north of Dillon Beach and on grazed hill slopes immediately north of the dunes. Nectar plants are available in the dunes and campground area, including *Grindelia stricta*, bull thistle, seaside daisy (*Erigeron glaucus*), and yellow sand verbena (*Abronia latifolia*). Myrtle's silverspots may be attracted to the site by nectar sources. Research on a related silverspot has shown nectar consumption to be important to total egg production by females (*Speyeria mormona*: Boggs & Ross 1993), and nectar consumption also probably affects male activity and longevity. Adult Myrtle's silverspots are rather opportunistic nectar feeders and will use flowers other than those listed above. The closely related Oregon silverspot (*Speyeria zerene hippolyta*) has been observed to nectar on *Aster chilense*, goldenrod (*Solidago* sp.), beach knotweed (*Polygonum paronychia*), *Hypochaeris radicata*, and yarrow (*Achillea millefolium*), all of which are present on the site. PRNS has recorded Myrtle's silverspots nectaring on additional plant species including *Limonium californicum*, *Hypochoeris glabra*, *Abronia umbellata*, and *Mentha pulegium* (Smick 2003).

On the basis of suitable habitat, nearby and possibly on-site observations, and the mobility of the species, I consider Myrtle's silverspot likely to be present on-site in at least some years. Scientifically and legally under the Endangered Species Act, the silverspot is classified as an animal, i.e., provisions of the ESA that apply to animals or wildlife apply to the butterfly. For example, unauthorized take of individual Myrtle's silverspots and alterations of habitat that harm them are prohibited and subject to serious penalties.

Pacific sand bear beetle, or bumblebee scarab (*Lichnanthe ursina* (LeConte 1861)) – federal Species of Concern, California Natural Diversity Data-base (CNDDB) rank G2S2 (globally and state endangered)

The Pacific sand bear beetle is known to occur on the site. I observed about five individuals of the species (three males and a pair *in copula*) in early May 2004 at the crest of a tall dune overlooking Brazil Beach. In the past the species has been observed near the old sand quarry (Monk & Associates 1999), and suitable habitat is present there and throughout much of the site.

The species is restricted to coastal sands in California, and according to CNDDB, may occur from northern San Mateo County to Bodega Head.

These large, sturdy beetles are sometimes classified as scarabs (Scarabaeidae) or often in a separate family (Glaphyridae). Because of their size, abundant yellowish hair, and a slight appearance of darker bands alternating with lighter on the abdomen, they bear a passing resemblance to a bumblebee. Few details are known of their life cycle, which is mostly underground. In flight season, adult beetles are active during the day. They are strong fliers. Adults emerge from belowground to seek mates. Comparable to other scarabs and consistent with behavior I observed, the females probably emit a pheromone that males follow to locate them. Eggs probably are laid belowground, and the grub-like larvae feed and grow underground, perhaps for more than one year. They may feed on plant detritus or roots or both. Pupation probably also is below the sand surface.

***Trigonoscuta* (*Panormus*) *tesselata raphani* Pierce 1975** (Coleoptera: Curculionidae (weevils)), no common name – no official federal or California status, but likely a very restricted endemic.

This 6-mm dappled gray-gold weevil is virtually unknown outside specialized entomological circles. It is part of a highly differentiated genus of flightless, nocturnal California dune weevils discussed by Pierce (1975), many of which are endemic to particular distinct patches of dunes. "Dillon Beach" is the type locality and the only known locality of the "Tomales tessellated dune weevil," which I suggest as an appropriate common name for *T. t. raphani*. The original specimens were collected on wild radish plants (*Raphanus* sp., mustard family (Brassicaceae)), although the food plants of the species are likely to be varied. More information on the biology of the genus (though not the species) may be found at the Endangered Species Recovery Program website, http://esrp.csustan.edu/speciesprofiles/profile.php?sp=trsp (accessed May 25, 2004).

I observed a similar but somewhat larger (8-mm) *Trigonoscuta* weevil at the site in early May, 2004.

There is suitable habitat on the site for the likely-endemic subspecies. Given the habitat and the weevil's previous documentation there, the subspecies should be presumed present without ample survey evidence to the contrary.

Globose dune beetle (*Coelus globosus* LeConte 1851) – federal Species of Concern, CNDDB rank G1S1 (highly endangered)

Monk & Associates (1999) reported that this species occurs in the Tomales dunes, including the sand quarry. I observed a tenebrionid beetle grossly resembling this species on-site in May 2004 (though it could be the more widespread *Coelus ciliatus*). Dedicated surveys are needed to determine the abundance and extent of the species' population in the Tomales dunes.

This small, black beetle is a member of the darkling beetle family (Tenebrionidae) (Doyen 1976). The species is flightless. It is restricted to coastal sand dunes, where it is usually found by digging in sand below plants. Adults may be active on the surface at night, or on cool foggy days. According to NatureServe.org the species has been recorded from coastal central and southern California, and from Baja California, Mexico. The Point Reyes National Seashore (PRNS) lists the species as occurring in the park (http://www.nps.gov/pore/nature_wldlf_tande.htm , accessed May 24, 2004). Both larvae and adults are believed to feed on detritus (NatureServe 2004a).

San Francisco forktail damselfly (*Ischnura gemina* (Kennedy 1917)) – no status presently noted on federal or state lists, although the species was formerly a federal species of concern. NatureServe (2004c) reports its status as G2S1S3 (globally imperiled, state vulnerable to critically imperiled); the IUCN classifies the species as Endangered.

This small (1-inch) damselfly reportedly has been seen on-site (tentatively identified by J. Evens, Avocet Research Associates; pers. comm. by P. Baye, June 2004).

The San Francisco forktail damselfly (Odonata: Coenagrionidae) is found in pools and slow-moving streams and canals and their immediate surroundings. Although it seems to have rather broad habitat tolerance, the species appears to be restricted to Marin, San Francisco, and San Mateo counties. It prefers waters with emergent herbaceous vegetation and no fish. The species is also found in PRNS, near Limantour Beach and the North Beach dunes, and on the lower reaches of Tomasini Creek, near Point Reyes Station (D. Adams, National Park Service - PRNS, pers. comm. June 2004).

Many of the dune slacks on-site with somewhat longer durations and at least some wetland vegetation may be suitable for this species.

San Francisco lacewing (*Nothochrysa californica* Banks 1892) – federal Species of Concern, CNDDB not ranked.

I have not turned up much information about this handsome lacewing (Neuroptera: Chrysopidae) (http://elib.cs.berkeley.edu/photos/fauna/cas-sci-Entomology.html; Toschi

1965). The CNDDB has no locality records for the species near the area. On their web site, PRNS indicates it is or may be present within the park.

Marin elfin butterfly (*Incisalia (Callophrys) mossii marinensis* Emmel, Emmel & Mattoon 1998) – federal Species of Concern, CNDDB rank T1S1 (subspecies highly endangered).

A relative of the endangered San Bruno elfin (*I. mossii bayensis*), this Marin County cousin has only recently been formally described and named (Emmel 1998). According to the USFWS, the Marin elfin is found in the "Dillon Beach area" on rock outcrops and bluffs (USFWS 1998, p. 117).

Larvae feed on *Sedum spathulifolium*, a stonecrop that lives in steep, rocky areas. Adults mostly fly in the vicinity of the larval host plant. There are some areas in the Tomales dunes vicinity that should be checked for potential to support the Marin elfin (i.e., presence of larval hostplant): portions of the 230-foot hill in section 33, bluffs along branches of the canyon east of Brazil Beach, and any other steep or rocky areas.

Sandy beach tiger beetle (*Cicindela hirticollis gravida* LeConte 1851) – federal Species of Concern, CNDDB rank T4S1 (apparently secure rangewide but with factors of concern, highly endangered within California).

The site is within the broad range of the species, and suitable habitat–sandy substrate near water–occurs on the site. I have not determined whether the species is known from the site. It is not listed in the vicinity by CNDDB. According to Dawn Adams of PRNS (pers. comm. June 2004) the species has been observed at PRNS, sometimes mixed in with individuals of *C. oregona*. Dedicated surveys for the species are needed to assess whether it is present in the Tomales dunes.

Tomales asellid (*Caecidotea tomalensis*, Isopoda: Asellidae) – CNDDB rank G2S2. Also known as Tomales isopod.

This species has not been reported to date from the Tomales dunes. Limited habitat may be available for it there.

The Tomales asellid is a freshwater isopod species known from Marin, Sonoma, San Francisco and San Mateo counties. Roughly 8 mm long, it vaguely resembles a cross between a tiny lobster and a silverfish. Many other members of the genus are cave isopods, but the Tomales asellid occurs aboveground in ponds and calm portions of streams. It prefers areas protected from current and with deposits of organic detritus. While mostly known from perennial waters, the species has been found in a few seasonal ponds (Fong 1996; L. Serpa, cited in Fong 1996).

Most dune slacks on the site are unlikely to support the species, being too short-lived and lacking substantial detritus deposits. A few of the deeper slacks might provide habitat. The area of the spring, to the extent there are detrital deposits, could be suitable, although year-

round shelter from high flows may be problematic for the species there. Focused surveys should be able to establish relatively quickly whether the species occurs on-site.

Ricksecker's water scavenger beetle (*Hydrochara rickseckeri* (Horn 1895)) – federal Species of Concern, CNDDB rank G1G2S1S2 (globally endangered to highly endangered, California endangered to highly endangered)

Relatively little is known of the habitat preferences of this rare species. It is known from freshwater seasonal wetlands. Some of the dune slacks may be suitable.

This aquatic beetle in the water scavenger beetle family (Hydrophilidae) has rarely been collected anywhere. NatureServe (2004b) lists the species from Alameda, Marin, Sonoma, Solano, and San Mateo counties; in particular, CNDDB lists a locality of the species in the Bolinas 7.5 minute quadrangle. In the absence of good information about the range and habitats of the species, no reasonable prediction can be made about the likelihood of the species' presence on-site. Only surveys can tell if it occurs at the Tomales dunes or not.

Point Reyes blue butterfly (*Icaricia icarioides* ssp. *parapheres* Emmel, Emmel & Mattoon 1998) – federal Species of Concern, CNDDB rank T1S1 (endemic to California and highly endangered)

This rare butterfly may not be highly likely to occur at the Tomales dunes, but this should be double-checked with field surveys. A close relative of the now-extinct Pheres blue (*I. i. pheres*), the butterfly now is known only from Point Reyes. It occurs in dune habitat. The larvae probably feed on one or more species of lupine (*Lupinus* sp.).

Special-status species <u>not</u> likely to occur

These species lack habitat on the site: (1) California freshwater shrimp (*Syncaris pacifica*, Crustacea, Decapoda: Atyidae) – federally listed as Endangered, California listed as Endangered. The site is within the species' range, but the shrimp inhabits low-gradient perennial streams with extensive riparian vegetation and deep undercut banks, a habitat not available on-site. (2) Sonoma arctic skipper (*Carterocephalus palaemon* ssp. *magnus* Mattoon & Tilden 1998, Lepidoptera: Hesperiidae) – federal Species of Concern. Inhabits redwood forest shade and clearing edges in Sonoma County.

5.3. Factors in Evaluating Land Use Impacts to Native Insects at the Tomales Dunes

Insects and other arthropods inhabiting the Tomales dunes may be affected by various human-controlled activities in the area.

<u>Trampling</u> – Both human and cattle traffic throughout the site result in considerable trampling of soils and vegetation. Trampling can directly injure insects underfoot, or break

down fragile soil structure that they rely on such as burrows, or injure flowers or vegetation they use for food, shelter, or substrate. It is fortunate that motorized vehicles are not allowed on the dunes, since their destructive potential in such a small area would be severe. Possible small indirect benefits of trampling–loosening sand dunes fixed by non-native species–must be weighed against the negative impacts and against the fact that such soil disturbance often enhances the establishment and spread of invasives. Direct control of non-native invasives is environmentally preferable.

Collecting – Certain attractive species may be pursued and captured by visitors to the dunes, whether casually or for collecting or trade. Data need to be gathered to assess this impact.

Grazing – Beyond the effects of trampling by cattle mentioned above, cattle consume plants used by insects, for example, larval host and nectar plants used by butterflies. Cattle may reduce the height and density of non-native grasses, but they also spread weed seeds in their feces and coats.

Water levels – Aquatic-dependent species rely on clean, undepleted surface and groundwater levels for suitable habitat in and around seasonal wetlands.

Invasive species – Non-native species, primarily plants but including a wide variety of other species, are increasingly likely to be introduced, and at higher volumes, the more people visit and modify the site. Permanent and effectively permanent homes and mobile-homes are often landscaped with non-native species that may escape and cause ecological problems (e.g., ice plant). Seeds and other propagules of non-native invasive species are also brought in inadvertently in mud and stuck to tires, wheel wells, shoes, and the like.

Lighting – Many species of crepuscular and nocturnal flying insects are attracted to artificial lights, where they may be injured by flying into things (not to mention "bug-zappers"), waste valuable time and energy needed for feeding or reproduction, or be captured by predators such as spiders or bats. The larger, closer, and brighter the lighting sources, the greater their impact. Moths, beetles, lacewings, and many other insect groups may be impacted to the point that species composition of the insect community is altered. With regard to the special-status species addressed above, most are either diurnal or flightless, but the Ricksecker's water scavenger beetle, if present, could be adversely impacted by artificial lighting. The possibility of effects on the Pacific sand bear beetle should be monitored.

Quarrying – sand mining is a direct cause of destruction and disturbance of dune habitat.

5.4. Summary – Insects of Tomales Dunes

The Tomales dunes provide a sizeable and relatively isolated area of active dune habitats, and as such are a relatively rare and unusual feature on the California coast. Their size, isolation, and distinctive dune habitats make them suitable for the evolution of local endemic insects, such as the "Tomales tessellated dune weevil." Other special-status dune specialist insects also occur there. More in-depth surveys are needed to understand the insect species using the area, notably the endangered Myrtle's silverspot butterfly. The habitats and species of the Tomales dunes are vulnerable to human activities and to non-native plant invasion.

The Tomales dunes are likely to be important in the recovery of a number of rare species, such as the Myrtle's silverspot. The USFWS recovery plan for the Myrtle's silverspot (USFWS 1998) states (p. 62):

> "One high-priority area of potentially suitable but apparently unoccupied habitat exists around and south of Dillon Beach, extending to south of Tom's Point. Much of this area overlaps or adjoins areas targeted for plant recovery actions in this plan, and could thus serve more than one recovery need. The feasibility of protecting this habitat, restoring habitat if needed, and re-introducing the Myrtle's silverspot butterfly should be investigated with highest priority."

[We have already noted that the Tomales dunes may be occupied by Myrtle's silverspot, not unoccupied.] The recovery plan also calls for, among other criteria, discovery or establishment of six 'new' populations at suitable, protected sites as a prerequisite for taking the species off the Endangered Species Act list. The Tomales dunes area (referred to in the recovery plan as the Dillon Beach dunes complex) is perhaps the best of potential 'new' sites within the range of the butterfly, for either discovery or establishment of a population to further recovery of the species. As is also noted in the plan, conservation of this habitat could aid the futures of several other species of concern (p. 115-119), many of which are discussed in this report.

6.0 Incidental wildlife observations at Tomales Dunes

In the course of botanical observations, other significant wildlife species were observed incidentally at Dillon Beach and Tomales Dunes. In most years between 1997 – 2004, I (and others, including Point Reyes Bird Observatory volunteers) have observed western snowy plovers (*Charadrius alexandrinus nivosus*, federally threatened) roosting or fleeing disturbances (unleashed dogs, pedestrians) on the wide backshore of the central and southern segments of the beach. I observed 4 individuals, 2 male, 2 female with breeding coloration on April 22 2004. They appear to use the beach as a wintering area; despite the physical suitability of the beach as nesting habitat, it appears to be too heavily disturbed to enable successful nesting. A Point Reyes Bird Observatory data collector had reported 16 western snowy plovers at Dillon Beach on April 16, and a mid-winter peak of 132 (J. Evens, pers. comm.), an exceptionally high density.

In 1999, I observed children successfully pursuing adult red-legged frogs (*Rana aurora*; subspecies undetermined) in flooded artificial ditches of western dune slacks adjacent to the campground area. I have not observed red-legged frogs in the perennial to seasonal ponds of the dune slacks, which support extremely dense populations of tree frogs (*Hyla regilla*) and immature, small western toads (*Bufo boreas*). In 2004 (April 22 and August 8), I also observed and photographed garter snakes, *Thamnophis* sp. (species undetermined, cf. *T. sirtalis*, with a conspicuous bright turquoise-blue belly and distinct red and light blue-greenish lateral stripes (Fig. 22).

7.0. SUMMARY

Tomales Dunes is floristically and geomorphically distinct from the better-known Point Reyes dunes system. It consists of two extensive dune sheets, a younger mobile one with extensive dune wetlands (slacks) and mobile, unstable ridges, and an older sheet that is stabilized and has formed soil. The structure, dynamics, and vegetation of the younger dune sheet are most similar to the historic outer San Francisco dunes. European beachgrass has fully invaded the foredunes, but it has only locally stabilized the large, mobile dunes, which continue to migrate and form dune slack wetlands. The dune slack wetlands are extensive and well-developed, forming some unique, distinctive marsh and aquatic plant assemblages and species not found at Point Reyes. Regionally rare plants found in Tomales dunes include the southern form of dune tansy (*Tanacetum camphoratum*, the only surviving population in Marin Co.), an endemic, ambiguous, intermediate wildrye (*Leymus*), an undetermined horsetail (*Equisetum* sp. or hybrid, close to *E. laevigatum* and *E.* x*ferrissii*), striate arrow-grass (*Triglochin striata*, the only reported Marin Co. population) and northern salt marsh bird's-beak (*Cordylanthus maritimus* ssp. *palustris*, in salt marsh fringing the eastern dunes). The federally endangere Tidestrom's lupine (*Lupinus tidestromii*) has been reported from one locality at Tomales Dunes, but is presumed to be extirpated, except for a possible persistent seed bank. Tomales Dunes supports highly suitable habitat within the geographic range of rare plants that may benefit from establishment of additional populations. These include Marin horkelia (*Horkelia marinensis*), Sonoma spineflower (*Chorizanthe valida*), Tidestrom's lupine (*Lupinus tidestromii*), and beach layia (*Layia carnosa*).

Many rare insects occur at Tomales Dunes. The threatened Myrtle's silverspot butterfly (*Speyeria zerene myrtleae*) occurs near Dillon Beach, and it is a likely visitor of abundant nectar plants in Tomales Dunes. The Pacific sand bear beetle (*Lichnanthe ursina*) is known to occur at Tomales Dunes. "Dillon Beach" is the type locality and the only known locality for *Trigonoscuta* (*Panormus*) *tesselata raphani,* a dune weevil with no common name. Globose dune beetle (*Coelus globosus*), considered highly endangered, has been reported from Tomales Dunes. The rare San Francisco forktail damselfly (*Ischnura gemina*) has been tentatively identified at Tomales Dunes.

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GLOSSARY

accretion: growth by accumulation, as in sediment

backshore: the beach zone above the intertidal zone in non-storm conditions, infrequently flooded, typically dry sand.

climbing dunes: dunes migrating over marine terraces, hillslopes, with base elevations well above sea level.

deflation: loss of substrate surface elevation due to wind erosion.

deflation plain: flats excavated by wind deflation of dunes to erosion-resistant surface, usually formed by either the capillary fringe of a water table, or accumulation of a lag surface (coarse particles too large for wind transport, forming an armored surface). See also *slack*.

dune, dunes: depositional features formed by wind-transported particles.

dune slack: see *slack*.

embryo foredune: early stages of foredune development, consisting of low, discontinuous, coalescing vegetated sand hummocks associated with pioneer beach and foredune vegetation.

foredune: the first line of vegetated coastal dunes landward of the beach. (*see relict foredune, embryo foredune*)

Gegenwall, (*plural* = *Gegenwälle*; original German): "counter-ridge"; residual low dune ridges or linear topographic highs in dune slacks outlining the former positions of the dune and slack margin as mobile dunes migrate downwind; derived from sand blown back to the vegetated slack edge from the unvegetated dune face, counter to dominant wind direction. Associated with slacks (deflation plains) of transverse dunes and U-dunes.

introgressants: hybrids backcrossed to natural parent species over single or multiple generations

paleodunes: ancient dunes associated with depositional environments or sea level positions that preceded contemporary ones; old, weathered dunes remnant from earlier geologic epochs.

progradation: depositional outgrowth of a shoreline towards the adjacent waterbody (seaward beach growth).

relict foredune: a residual stabilized, vegetated coastal dune ridge landward of the foredune at the back of the beach, left at the position of a former foredune/beach boundary as the shoreline and foredune positions prograde seaward.

runnel: a topographic low trough formed behind an emerging beach ridge or intertidal swash bar (wave-built sand bar), associated with longshore currents or temporary backshore ponds.

scarp (dune scarp): a near-vertical cliff eroded in unconsolidated but weakly cohesive moist sand, often in foredunes or beaches (wave-cut scarps), seasonal stream canyons or gulches eroded through dunes, or wind-eroded slopes.

slack (*dune slack*): Topographic low areas in coastal dune systems, either deflation plains or hollows formed by wind erosion of coastal dunes; usually depressional seasonal wetlands (marshes, swamps, ponds) or seasonal wetland flats.

slipface: steep backslopes of dunes lying at the angle of repose for dry sand, near 32°.

transverse dunes: mobile, unvegetated, sinuous dune ridges with long axes perpendicular to the dominant wind direction, gentle windward slopes, and steep lee slopes, resembling large-scale sand ripples.

U-dunes (*syn: parabola dune, parabolic dune*) : at least partially vegetated dunes with a U-shaped or roughly parabolic configuration, with the opening of the "U" facing upwind and, consisting of: (a) partially or fully vegetated flanks aligned with the dominant wind direction, (b) an interior deflation zone (a dune hollow or deflation plain, dune slack), and (c) a concave-windward head, either unvegetated and mobile, partially vegetated, or fully stabilized by vegetation.

Appendix 1:
Partial Flora of Tomales Dunes

The flora of Tomales Dunes covers vascular plants growing spontaneously (not directly planted) in natural substrates of the dunes, beaches, and wetlands of the Tomales Dunes. It excludes purely artificial substrates (e.g. roadbeds, soil fill) and older coastal cliffs, bluffs, grasslands (sandstone-derived soils) of adjacent terrestrial habitats. One non-vascular plant, a charophyte (green alga) that structurally mimics submerged vascular aquatic plants, is also included.

The flora of Tomales Dunes has been incompletely surveyed. The partial flora below is compiled from multiple sources, including original surveys. Previous surveys and reports of plant localities including Tomales Dunes vary inconsistently in geographic and ecological scope. One CNPS survey (Smith 1998) covered the "Dillon Beach Area", including coastal sandstone bluffs and terrestrial grasslands and bedrock outcrops. Another CNPS survey (CNPS 2001) was specific to the Lawson Landing dunes. Plant species lists from Monk and Associates (1999) covered only the vicinity of the sand quarry. "Dillons Beach" and "near Dillons Beach" localities reported in Howell (1949) appear to include both dune and non-dune habitats. Observations made by Baye intermittently since 1997have been limited to the younger dune sheet (late Holocene), and limited portions of the paleodune sheet. The majority of the paleodune sheet, extending from eastern limits of Lawsons Landing property to north of Tom's Point, has not been surveyed.

The following partial flora of the dunes was selectively compiled from CNPS surveys, the historic Marin Flora (Howell 1949) and recent partial surveys (Baye 1997-2004). Species reported by Smith (1998) that are primarily associated with non-dune vegetation, and which were not found in recent surveys or other reports, were omitted from this partial flora.

Families and nomenclature here follow the Jepson Manual (Hickman 1993) and minor corrections published by the Jepson Herbarium. Much taxonomic revision has occurred, or is in progress, since the publication of the Jepson Manual. Many taxa treated here have been placed in different families, and many species and subspecies treatments are in revision.

Non-flowering plants

CHAROPHYTA – CHARACEAE

species	common name	vegetation/habitat	local distribution, abundance	references
Chara sp. (undetermined)	stonewort, muskgrass	calcareous dune slack pond	rare, local	Baye 2004

SPHENOPHYTA - EQUISITACEAE

botanical name	common name	vegetation/habitat	local distribution, abundance	references
Equisetum undet. taxon (aff. ***E.*** x***ferrisii*****, *E.***	hybrid (?) smooth scouring rush	dune slack	local	Baye 2004

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laevigatum Clute

Flowering plants

AIZOACEAE

botanical name	common name	vegetation/habitat	local distribution, abundance	references
Carpobrotus chilensis (L.) N.E. Br.	Chilean iceplant	stable dune scrub, foredunes	infrequent, locally abundant invasive alien	
Carpobrotus edulis (Molina) N.E. Br. **(includes hybrids with *C. chilensis*)**	Iceplant, hottentot-fig	stable dune scrub, foredunes ruderal sandy soils	infrequent, locally abundant invasive alien	
Conicosia pugioniformis (L.) N.E. Br.	slender iceplant	stable dune scrub	widespread, common invasive alien	

ANACARDACEAE

botanical name	common name	vegetation/habitat	local distribution, abundance	references
Toxicondendron quercifolium (Torrey & A. Gray) E. Greene	poison oak	eastern stable old dune scrub	local (scarce in Lawsons Landing parcel)	Baye 1997-2004 Smith 1998

APIACEAE

botanical name	common name	vegetation/habitat	local distribution, abundance	references
Anthriscus caucalis M. Bieb.	bur-chervil	stable dunes, ruderal sandy soils	local, alien	Howard 2001 Monk 1999
Conium maculatum L.	poison hemlock	ruderal sandy soils	local, alien	Howard 2001
Daucus pusillus Michaux	rattlesnake weed	stable foredune grassland, stable dune scrub	widespread, locally common	Baye 1997-2004
Foeniculum vulgare Mill.	fennel	ruderal sandy soils	local invasive alien	Howard 2001 Smith 1998
Glehnia littoralis (A. Gray) Miq. ssp. ***leiocarpa*** (Mathias) Hulten	beach-parsley	foredune, strand	rare, historic; southern historic limit of subspecies	Howell 1949
Heracleum lanatum Michaux	cow-parsnip	mesic stable dunes, slacks	occasional, local	Monk 1999
Hydrocotyle ranunculoides L.	marsh pennywort	seasonal ponds, perennial marsh, wet dune slack	infrequent	Baye 1997-
Hydrocotyle verticillata Thunb.	marsh pennywort	seasonal ponds, perennial marsh,	infrequent, locally common	Baye 1997-2004

		wet dune slack		
Lilaeopsis occidentalis Coulter & Rose	western lilaeopsis	perennial or seasonal marsh, wet dune slack	locally common to abundant, not widespread	Baye 1997-2004

ASTERACEAE

botanical name	common name	vegetation/habitat	local distribution, abundance	references
Achillea millefolium L.	yarrow	stable dune scrub, grassland	occasional	Baye 1997-2004
Agoseris apargiodies var. ***eastwoodiae***		stable dune scrub, grassland	occasional, locally common	Baye 1997-2004
Ambrosia chamissonis (Less.) E.Greene	beach-bur	foredunes, mobile dunes, young dune scrub	common	Howell 1949
Baccharis pilularis DC.	coyote brush	dune scrub, stable foredune	common	
Carduus pycnocephalus L.	Italian thistle	disturbed mesic dune scrub	locally common invasive alien	
Cirsium brevistylum Cronq.	Indian thistle	dune seeps, springs, mesic dune slack	uncommon	
Cirsium quercetorum (A. Gray) Jepson	brownie thistle	dune scrub	uncommon, local	
Cirsium vulgare (Savi) Ten.	bull thistle	mesic dune slack, ruderal vegetation	occasional, locally common	
Cotula australis (Sieber) Hook.	annual brass-buttons	ruderal vegetation	uncommon,alien	
Cotula coronopifolia L.	brass-buttons	wet dune slack, seasonal dune spring-fed channel bed	uncommon, alien	
Erechtites glomerata (Poiret) DC.	fireweed	stable foredunes, mesic dune slacks	infrequent, locally common invasive alien	
Erechtites minima (Poiret) DC.	fireweed	stable foredunes, mesic dune slacks	infrequent, locally common invasive alien	
Ericameria ericoides (Less.) Jepson	mock-heather	dune scrub, stable relict foredune	common to dominant	Howell 1949
Erigeron glaucus Ker-Gawler	seaside daisy	stable dunes	occasional	
Eriophyllum staechadifolium Lascaga	lizard tail	stable dune scrub	occasional	
Filago gallica L.	French filago	stable dune, ruderal sandy soils	occasional	
Gnaphalium luteo-album L.	yellow-white cudweed	ruderal sandy soils	occasional, alien	
Gnaphalium purpureum L.	purple cudweed	ruderal sandy soils	occasional	
Gnaphalium palustre Nutt.	marsh cudweed	dune slack	locally common	Howell 1949

Gnaphalium stramineum Kunth	straw cudweed	mesic dune slack, ruderal sandy soils	occasional	Howell 1949
Hedypnois cretica (L.) Dum.-Cours.	Cretan dandelion	ruderal sandy soils, dune slack	locally common,alien	
Hypochaeris glabra L.	smooth cat's-ear	ruderal sandy soils, mesic dune slack	locally common, alien	
Hypochaeris radicata L.	rough cat's-ear	ruderal sandy soils, mesic dune slack	locally common, alien	
Jaumea carnosa (Less.) A. Gray	fleshy jaumea	brackish dune slack, brackish tidal marsh	uncommon, locally abundant	
Picris echoides L.	bristly ox-tongue	ruderal sandy soils, mesic dune slack	occasional alien	
Psilocarphus tenellus Nutt. var. ***tenellus***	slender woolly-marbles	mesic dune slack, ruderal sandy soils	locally common	
Senecio vulgaris L.	common groundsel	ruderal sandy soils, mesic dune slack, stable dune	occasional, locally common alien	
Soliva sessilis Ruiz-Lopez & Pavon	soliva	ruderal sandy soils, mesic dune slack	uncommon alien	
Sonchus asper (L.) Hill	prickly sow-thistle	soils, mesic dune slack	uncommon, alien	
Sonchus oleraceus L.	sow-thistle	soils, mesic dune slack	uncommon, alien	
Tanacetum camphoratum Less.	dune tansy	stable dune grassland, mesic dune slack	rare, locally abundant	

BORAGINACEAE

botanical name common name vegetation/habitat local distribution, abundance references

Amsinckia spectabilis Fischer & C. Meyer var. ***spectabilis***	coast fiddleneck	dune scrub	occasional, locally common	
Cryptantha leiocarpa (Fischer & C. Meyer) E. Greene	dune cryptantha	dune scrub (gaps)	common	
Heliotropium curassavicum L.	heliotrope	sandy bay shoreline (rarely seasonal ponds of young dune slack)	uncommon	

BRASSICACEAE

botanical name common name vegetation/habitat local distribution, abundance references

Cakile maritima (Bigelow) Hook.	sea rocket	beach, embryo foredune, sandy bay shoreline	common to dominant, alien	
Capsella bursa-pastoris (L.) Medikus	shepherd's-purse	ruderal sandy mesic soil	local, alien	

Coronopus didymus (L.) Smith	wartcress	ruderal sandy mesic soil, disturbed mesic slack	occasional, locally common,alien	
Lepidium strictum (S. Watson)	narrow peppercress	(no data; expected in old stable dune)	uncommon	
Rorripa nasturium-aquatica (L.) Hayek	watercress	dune spring, bayshore seep freshwater marsh	local, locally abundant	

CALLITRICHACEAE

botanical name common name vegetation/habitat local distribution, abundance references

Callitriche heterophylla Pursh. var. ***heterophylla***	water starwort	wet dune slack (seasonal pond)	infrequent but locally common	

CARYOPHYLLACEAE

botanical name common name vegetation/habitat local distribution, abundance references

Cardionema ramossisimum (J.A. Weinm.) Nenson & J. F. Macbr.	sandmat	dune scrub (gaps)	common	
Cerastium arvense L.	field chickweed	mesic dune scrub	uncommon	
Cerastium fontanum Baumg. ssp. ***vulgare***	chickweed	no data	no data; alien	reported by Howard 2001
Cerastium glomeratum Thuill.	mouse-ear chickweed	ruderal sandy soil, mesic dune slack	uncommon, alien	
Paronychia franciscana Eastw.	whitlow-wort	ruderal sandy soil	alien	
Sagina decumbens (Elliot) Torrey & Gray var. ***occidentalis*** (S. Watson) G. Crow	western pearlwort	ruderal sandy soil, dune scrub	occasional	
Sagina maxima A. Gray var. ***crassicaulis*** (S. Watson) G. Crow	coast pearlwort	disturbed scarps in dune seeps, bedrock outcrop	local, uncommon	
Silene gallica L.	corn spurrey	ruderal sandy soil, dune scrub	occasional, locally common	Monk 1999
Spergula arvense L.	spurrey	ruderal sandy soil	occasional alien	Howell 1949 Monk 1999
Spegularia macrotheca (Hornem.) Heynh	coast spurrey	sandy salt marsh	occasional, local	
Stellaria littoralis Torrey	shore starwort	mesic dune slack	uncommon, locally abundant	

Stellaria media (L.) Villars	common chickweed	ruderal sandy soil	occasional, locally common	

CHENOPODIACEAE

botanical name	common name	vegetation/habitat	local distribution, abundance	references
Atriplex californica Moq.	California saltbush	no data; expected at bayshore high tide line, in sand	rare	Howard 2001
Atriplex leucophylla (Moq.) D. Dietr.	beach or whiteleaf saltbush	beach drift-lines, embryo foredunes	uncommon, intermittent (not detected 2003-4)	
Atriplex triangularis Willd.	spearscale, fat-hen	brackish dune slack, salt marsh	occasional	Baye 2004
Chenopodium ambrosioides L.	Mexican-tea	ruderal sandy soil, dune slack	no data; alien	
Chenopodium macrospermum Hook. var. ***halophilum*** (Phillipi) Standley	large-seeded salt goosefoot	emergent bare moist sand of brackish lagoons or dune slack edges	rare, local	Baye 2004
Salicornia virginica L.	perennial pickleweed	salt marsh	locally abundant	

CRASSULACEAE

botanical name	common name	vegetation/habitat	local distribution, abundance	references
Crassula aquatica (L.) Schonl.	water pygmy-weed	sparsely vegetated seasonal pools	no data	Howard 2001
Crassula connata (Ruiz Lopez & Pavon)	sand pygmy-weed	stable dune scrub gaps	no data	

FABACEAE

botanical name	common name	vegetation/habitat	local distribution, abundance	references
Lotus micranthus Benth.	small-flowered lotus	stable dune scrub	no data	Howell 1949
Lotus formisissimus E, Greene	coast lotus	mesic dune slack	no data	Howell 1949
Lotus heermanii (Durand & Hilg) E. Greene var. ***orbicularis*** (A. Gray) Isely	woolly-stem lotus	paleodune	uncommon	Baye 1998
Lupinus arboreus Sims	yellow bush lupine	stable dunes	common to dominant	
Lupinus bicolor Lindley	miniature lupine	stable dune, paleodune	uncommon	
Lupinus	Tidestrom's lupine	stable dune gaps	presumed extirpated	

tidestromii E. Greene				
Trifolium depauperatum Desv.	cow clover	dune slacks	undetermined	Howell 1949
Trifolium macraei Hook. & Arn.	twinhead clover	dune slacks	undetermined	Howell 1949
Trifolium wormskioldii Lehm.	cow clover	dune slacks	widespread, common to abundant	

GERANIACEAE

botanical name common name vegetation/habitat local distribution, abundance references

Erodium botrys (Cav.) Bertol.	filaree	mesic dune slacks, ruderal sandy soils	occasional, locally common, alien	Howard 2001
Erodium cicutarium (L.) L'Her	red-stem filaree	mesic dune slacks, ruderal sandy soils	occasional, locally common, alien	Howard 2001
Geranium dissectum L.	cutleaf filaree	mesic dune slacks, ruderal sandy soils	occasional, locally common, alien	Howard 2001
Geranium molle L.	softleaf geranium	mesic dune slacks, ruderal sandy soils	occasional, locally common, alien	Howard 2001

HYDROPHYLLACEAE

botanical name common name vegetation/habitat local distribution, abundance references

Phacelia californica Cham.	California phacelia	dune scrub, (recent and paleodune)	occasional	Baye 1997-2004
Phacelia distans Benth.	fernleaf phacelia	dune scrub, (recent and paleodune)	common	Baye 1997-2004, CNPS 2001

LAMIACEAE

botanical name common name vegetation/habitat local distribution, abundance references

Mentha pulegium L.	pennyroyal	disturbed dune slacks (cattle path or wallow)	occasional	
Stachys ajugoides Benth. var. ***rigida*** Jepson & Hoover	hedge-nettle	mesic dune scrub, paleodune	uncommon	

LYTHRACEAE

botanical name common name vegetation/habitat local distribution, abundance references

Lythrum hyssopifolium L.	hyssop-leaved loosetrife	disturbed dune slacks (cattle path or wallow), puddled ruderal sandy soils	occasional, locally common	

HYDROPHYLLACEAE

botanical name	common name	vegetation/habitat	local distribution, abundance	references
Phacelia californica Cham.	California phacelia	dune scrub, (recent and paleodune)	occasional	Baye 1997-2004
Phacelia distans Benth.	fernleaf phacelia	dune scrub, (recent and paleodune)	common	Baye 1997-2004

MYRICACEAE

botanical name	common name	vegetation/habitat	local distribution, abundance	references
Myrica californica Cham. & Schindl.	California wax-myrtle	dune slack, mesic dune scrub (seep)	uncommon	

NYCTAGINACEAE

botanical name	common name	vegetation/habitat	local distribution, abundance	references
Abronia latifolia Eschsch.	yellow sand-verbena	foredune, mobile dunes, young dune scrub or grassland	common in interior mobile and stable dunes, uncommon in foredunes	Baye 2004
Abronia umbellata Lam. ssp. ***breviflora*** (Standley) Munz (note: diagnosis uncertain; may be introgressant)	north coast pink sand verbena	beach, embryo foredune, bayshore beach	rare	Smith 1998

ONAGRACEAE

botanical name	common name	vegetation/habitat	local distribution, abundance	references
Camissonia cheiranthifolia (Sprengel) Ram ssp. ***cheiranthifolia***	beach evening-primrose	stable open sandy gaps in dunes	common	
Camissonia contorta (Dougl.) Raven	twisted sand suncup	gaps in dune scrub, stable foredune, paleodune	occasional, locally common	
Camissonia micrantha (Sprengel) Raven	small-flowered sand suncup	gaps in dune scrub, stable foredune, paleodune	occasional, locally common	
Epilobium ciliatum Raf. ssp. ***watsonii*** (Barbey) P. Hoch & Raven	coast willowherb	dune slack	occasional	Howell 1949

PAPAVERACEAE

botanical name	common name	vegetation/habitat	local distribution, abundance	references
Eschscholzia californica Cham.	California poppy	stable dune scrub, paleodune	occasional, locally common to abundant	

PLANTAGINACEAE

botanical name	common name	vegetation/habitat	local distribution, abundance	references

Plantago coronopus L.	cutleaf plantain	seasonally wet ruderal areas, disturbed dune slacks	uncommon, alien	
Plantago elongata Pursh.	coast annual plantain	brackish dune slack,	uncommon	
Plantago erecta E. Morris	dwarf plantain	paleodune gaps	uncommon	
Plantago lanceolata L.	English plantain	seasonally wet ruderal areas, disturbed dune slacks	occasional, alien	
Plantago major L.	common plantain	seasonally wet ruderal areas, disturbed dune slacks	occasional, alien	
Plantago maritima L.	coast plantain	tidal marsh	infrequent, locally common	
Plantago subnuda Pilger	seep plantain	dune seep wetlands	infrequent	

POLYGONACEAE

botanical name common name vegetation/habitat local distribution, abundance references

Chorizanthe cuspidata S. Watson [incl. vars. *cuspidata* and *villosa* (Eastw.) Munz]	San Francisco spineflower, woolly spineflower	stable dune scrub gaps, gaps in stable foredunes, disturbed dry dune slack	widespread, common	Howell 1949, Baye 1997-2004
Polygonum arenastrum Boreau	doorweed	seasonally wet ruderal areas, disturbed dune slacks	occasional	Baye 1997-2004
Polygonum paronychia Cham. & Schindl.	sand knotweed	stable dune scrub	occasional	
Pterostegia drymarioides Fischer & C. Meyer	granny's hairnet	stable dune scrub gaps, gaps in stable foredunes, disturbed dry dune slack	occasional, locally common	Howell 1949 Baye 1997-2004
Rumex acetosella L.	sheep-sorrel	stable dune scrub gaps, gaps in stable foredunes, disturbed dry dune slack	common	Baye 1997-2004
Rumex crispus L.	curly dock	disturbed wet slacks	occasional, locally common	Baye 1997-2004
Rumex salicifolius J.A. Weinm. ssp. ***crassus*** (Rech. f.) J. Howell	fleshy willow dock	sparsely vegetated wet dune slacks, upper edges of tidal marsh	infrequent	Howell 1949 Baye 1997-2004

PORTULACACEAE

botanical name	common name	vegetation/habitat	local distribution, abundance	references
Claytonia perfoliata Willd.	miner's-lettuce	dune scrub, stable foredune (winter ephemeral, ground layer)	widespread, common, locally abundant	Baye 1997-2004

PRIMULACEAE

botanical name	common name	vegetation/habitat	local distribution, abundance	references
Anagallis arvensis L.	pimpernel	stable dune scrub gaps, disturbed dune slack	occasional	Baye 1997-2004

RANUNCULACEAE

botanical name	common name	vegetation/habitat	local distribution, abundance	references
Ranunculus aquatilis L.	aquatic buttercup	dune slack ponds	uncommon, local	Baye 2004
Ranunculus muricatus L.	spiny-fruit buttercup	dune slack	no data	CNPS 2001

ROSACEAE

botanical name	common name	vegetation/habitat	local distribution, abundance	references
Fragaria chiloensis (L.) Duchesne	beach strawberry	stable dunes	occasional, locally common	
Potentilla anserina L. ssp. ***pacifica*** (Howell) Rousi	Pacific silverweed	dune slack, brackish tidal marsh	abundant to dominant	

RUBIACEAE

botanical name	common name	vegetation/habitat	local distribution, abundance	references
Galium aparine L.	goosegrass bedstraw	mesic dune slack, ruderal sandy soils	uncommon	

SALICACEAE

botanical name	common name	vegetation/habitat	local distribution, abundance	references
Salix lasiolepis (incl. var. ***bigelovii***	arroyo willow	dune slack	uncommon	
Salix sitchensis	sitka willow	dune slack	uncommon	

SCROPHULARIACEAE

botanical name	common name	vegetation/habitat	local distribution, abundance	references

Cordylanthus maritimus Benth. ssp. ***palustris*** (Behr) Chuang & Heckard	northern salt marsh bird's-beak	high tidal salt marsh	rare, possibly extirpated or intermittent	CNPS 2001 Fletcher 2000
Mimulus guttatus DC.	monkeyflower	dune slack, seeps	infrequent, locally common	
Scrophularia californica ssp. ***californica*** Cham. & Schindl.	California bee-plant	mesic dune scrub, paleodune	uncommon	
Veronica anagallis-aquatica L.	water-pimpernel speedwell	wet dune slack	no data	

SOLANACEAE

botanical name	common name	vegetation/habitat	local distribution, abundance	references
Solanum sp. (S. nigrum, S. americanum, not det.)	nightshade	mesic dune slack, ruderal sandy soil		

URTICACEAE

botanical name	common name	vegetation/habitat	local distribution, abundance	references
Urtica dioica L. ssp. ***holosericea*** (Nutt.) Thorne	stinging nettle	dune spring	rare, local	Baye 2004

Monocotyledons

CYPERACEAE

botanical name	common name	vegetation/habitat	local distribution, abundance	references
Carex obnupta L. Bailey	slough sedge	wet dune slack	uncommon, local	
Eleocharis macrostachya Britton	common spikerush	wet dune slack and ponds	very common, locally abundant	
Eleocharis pauciflora (Light) Link	small-flowered spikerush	freshwater marsh, presumed dune slack	no data; probably uncommon	CNPS 2001
Scirpus cernuus Vahl	dwarf clubrush	brackish tidal marsh, seeps	occasional	
Scirpus pungens Vahl	common threesquare, coast bulrush	brackish tidal marsh, wet dune slack and ponds	common	

JUNCACEAE

botanical name	common name	vegetation/habitat	local distribution, abundance	references

Juncus bufonius L.	toad rush	dune slack, tidal brackish marsh	occasional	
Juncus lescurii Bolander (syn. *J. leseurii*; incl. *J. breweri* Engelm.)	salt rush	dune slack; also mobile dunes and stable dunes	very common	
Juncus phaeocephalus Engelm. var. ***phaeocephalus***	brown-headed rush	dune slack	common	

JUNCAGINACEAE

botanical name	common name	vegetation/habitat	local distribution, abundance	references
Triglochin striata Ruiz Lopez & Pavon	striped or three-ribbed arrow-grass	wet dune slack, pond edge	rare (1 locality confirmed locally)	Howell 1949, Baye 2004

LEMNACEAE

botanical name	common name	vegetation/habitat	local distribution, abundance	references
Lemna sp.	duckweed	dune slack, pond	occasional, intermittent	CNPS 2001, Baye 2004

ORCHIDACEAE

botanical name	common name	vegetation/habitat	local distribution, abundance	references
Platanthera leucostachys Lindley	swamp orchid	"marshy meadows" (Howell 1949) [= dune slack?]	reported historically present "Dillons Beach" (Howell 1949)	Howell 1949 Smith 1998
Spiranthes romanzoffiana Cham.	hooded ladies'-tresses orchid	dune slack	rare, local (with Equisetum)	Baye 2004, CNPS 2004

POACEAE

botanical name	common name	vegetation/habitat	local distribution, abundance	references
Agrostis blasdalei A. Hitchc.	Blasdale's bentgrass	no local data; typically on sandy coastal bluffs or dunes	rare; not verified for Tomales Dune habitats; reported "Dillons Beach"	Howell 1949
Agrostis halllii Vasey	Hall's bentgrass	no local data; "brushy slopes"	not verified for Tomales Dune habitats; reported "Dillons Beach"; this spp. or *A. pallens* expected on dunes.	Howell 1949
Agrostis stolonifera L.	creeping bentgrass	dune slack, brackish marsh	locally common, alien	Baye 2004
Aira caryophyllea L.	silver hairgrass	ruderal sandy soils, stable dunes	occasional, alien	
Ammophila arenaria (L.) Link	marram (UK), European beachgrass (CA)	foredunes, mobile dunes, persisting in stable dunes	widespread, dominant	
Avena barbata Link	beared oat	ruderal sandy soils, stable dunes (usually with old *Lupinus arboreus*)	occasional, alien	
Briza minor L.	small rattlesnake-	ruderal sandy soils,	occasional, alien	

	grass	stable dunes (with old *Lupinus arboreus*)		
Bromus diandrus Roth	ripgut brome	ruderal sandy soils, stable dunes (with old *Lupinus arboreus*)	locally abundant; alien	
Bromus hordeaceus L.	soft brome	ruderal sandy soils	uncommon; alien	
Bromus tectorum L.	cheat grass	ruderal sandy soils	no data; alien	CNPS 2001
Cynodon dactylon (L.) Pers.	Bermuda grass	dune seeps, dune slacks disturbed by grazing	widespread, locally abundant or dominant, alien	
Dactylis glomerata L.	orchard grass	dune seeps, dune slacks disturbed by grazing	uncommon	CNPS 2001
Distichlis spicata (L.) E. Greene	saltgrass	salt marsh, mesic dune slack	locally abundant	Baye 2004
Glyceria occidentalis (Piper) J.C. Nelson	western mannagrass	winter-flooded pools (dune slack ponds?)	rare in Marin Co (1 locality nr. Olema reported by Howell 1949)	Smith 1998,
Holcus lanatus L.	velvetgrass	dune seeps, dune slacks disturbed by grazing	occasional, locally abundant	Baye 2004
Hordeum branchyantherum Nevski	meadow barley	dune slacks, brackish tidal marsh edges	occasional, locally common	CNPS 2001, Baye 2004
Hordeum marinum Hudson ssp. ***gussoneanum*** (Parl.) Thell.	Mediterranean barley	ruderal sandy soils, stable dunes (with old *Lupinus arboreus*)	occasional, locally common, alien	CNPS 2001, Baye 2004
Hordeum murinum L. ssp. ***leporinum*** (Link) Arcang	foxtail barley	ruderal sandy soils, stable dunes	occasional, alien	CNPS 2001, Baye 2004
Leymus pacificus (Gould) D.R. Dewey	Pacific coast wildrye	stable dunes	rare	Smith 1998, Baye 1997-2004
Leymus pacificus (Gould) D.R. Dewey x (?) ***triticoides*** (Buckley) Pilger	(intermediate Pacific, creeping wildrye)	stable dunes near seeps	rare	Baye 1997-2004
Leymus x***vancouveriensis*** (Vasey) Pilger	Vancouver wildrye	bayshore sandy high marsh, low bay dunes	occasional, locally abundant	Smith 1998, Baye 2004
Leymus pacificus x x***vancouveriensis*** (?)	(anomalous, nameless endemic dune wildrye)	dune scrub and adjacent mobile dunes encroaching scrub	rare, locally abundant	Baye 1997-2004
Lolium multiflorum Lam.	Italian ryegrass	ruderal mesic sandy soils (roadside), grazed dry dune slack	occasional	CNPS 2001, Baye 2001
Parapholis	sicklegrass	saline or brackish	uncommon	CNPS 2001

incurva (L.) C.E. Hubb.		seasonal wetlands		
Paspalum dilatatum Poiret	dallisgrass	wet or flooded dune slack, seeps	occasional, alien	CNPS 2001, Baye 2004
Paspalum distichum L.	joint paspalum	wet or flooded dune slack, seeps	occasional, native	CNPS 2001, Baye 2004
Pennisetum clandestinum Chiov.	kikuyu grass	dune seeps, dune slacks disturbed by grazing	occasional, locally abundant or dominant, alien	
Poa douglasii Nees	Douglas' bluegrass	stable dune	one locality confirmed [Baye] at Lawson Landing Dunes residence; may be planted; absent in stable or mobile dunes	Smith 1998, Baye 2004
Polypogon interruptus Kunth.	ditch beardgrass	seasonal wetlands	no data; alien	CNPS 2001
Polypogon monspeliensis (L.) Desf.	rabbit's-foot grass	dune slacks, seasonal wetlands	occasional, locally common, alien	CNPS 2001, Baye 2004
Vulpia bromoides (L.) S.F. Gray	brome fescue	ruderal sandy soils	no data, alien	CNPS 2001
Vulpia myuros (L.) C. Gmelin	rattail fescue	ruderal sandy soils	no data, alien	CNPS 2001
Vulpia octoflora (Walter) Rydb. ssp. ***hirtella*** (Piper) Henrard	annual eight-flowered fescue	ruderal sandy soils	no data	CNPS 2001

POTAMOGETONACEAE

botanical name	common name	vegetation/habitat	local distribution, abundance	references
Potamogeton foliosus Raf.	leafy pondweed	dune slack ponds	uncommon, locally abundant	Howell 1949 Baye 2004
Potamogeton nodosus Poiret	broadleaf pondweed	dune slack ponds	uncommon, locally abundant	Howell 1949 Baye 2004

RUPPIACEAE

botanical name	common name	vegetation/habitat	local distribution, abundance	references
Ruppia maritima L.	wigeongrass, ditchgrass, Ruppia	flooded salt pans, brackish lagoons	tidal marsh near Brazil Beach	Baye 2004

ZANNICHELLIACEAE

botanical name	common name	vegetation/habitat	local distribution, abundance	references
Zannichellia palustris L.				

Appendix 2:
Significant botanical features of Tomales Dunes

The following discussions highlight plant populations at Tomales Dunes that have special ecological, biogeographic, or taxonomic significance in the context of biological diversity conservation in California coastal dunes. Criteria for significance include taxonomic distinction (e.g., type localities, places from which original "type" of the taxon was collected and first described; anomalous populations with phenotypic variability exceeding descriptions of published taxa), important geographic variation among plant populations (e.g., distinctive ecotypes or phenotypes, evidence of exceptional introgression (hybrid backcrossing) among taxa); distinctive community-level ecological traits (forming unusual, rare, or major representative types of plant associations or communities), or conservation significance due to geographic distribution (range limits, disjunct or remote isolated populations) or abundance (rarity, threatened or endangered status).

Abronia umbellata ssp. ***breviflora, A. umbellata* x *latifolia*** (pink sand-verbenas; Nyctaginaceae, four-o'-clock family). This predominantly north coast subspecies of *Abronia umbellata* generally occurs on beaches and embryo foredunes, often in depositional environments such as washovers, ends of sand spits, or estuarine beaches. It is subject to occasional local extirpation and recolonization (Kaye 1999). The subspecies is difficult to distinguish from back-crossed hybrids (introgressants) between the more widespread yellow sand-verbena (*A. latifolia*) and *A. umbellata* ssp. *umbellata*, from which it (or some populations that fit the subspecies in botanical keys) may be derived (Tillett 1966). Some putative A. *umbellata* ssp. *breviflora* populations at Point Reyes (Drakes Bay) are sterile hybrid intermediates (P. Baye, unpublished data). *A. umbellata* ssp. *breviflora* has been reported from Dillon Beach by Smith (1998), but critical taxonomic assessment of the population

Artemisia pycnocephala – present in the area (bluffs N of Dillon Beach; Pt. Reyes dunes), and abundant suitable dune habitat exists in Tomales Dunes, but this common to abundant species of early stages of dune stabilization is anomalously absent or very scarce here.

Atriplex californica California saltbush; Chenopodiaceae). This low, creeping subshrub seldom occurs in coastal dunes in the northern portion of its range; in Marin County, it is found mostly on sandy estuarine beaches and salt marsh edges, and on sandstone coastal bluffs. It was reported in the composite

CNPS species list (Howard 2001). If it was indeed found in Tomales Dunes, it would be an exceptional habitat and locality.

Chorizanthe cuspidata (Spineflower; Polygonaceae). Tomales Dunes, Point Reyes dunes and north Bodega Harbor dunes are locations where the two formerly recognized varieties of this species (vars. *cuspidata* and *villosa*) occur together, and in some cases intergrade. They are diagnostically distinguished by the hooked (var. *cuspidata*) or straight (var. *villosa*) teeth of the involucre (spiny structures that facilitate dispersal of the seed-bearing dry fruits on animal fur). Typical *C. c.* var. *cuspidata* occurs on the San Francisco peninsula; the species at its northern limit at Horseshoe Cove, northwest Sonoma County (Salt Point State Park) comprised only var. *villosa*. The Tomales Dunes populations are the largest in the northern extreme of its range. They appear to be actively invading small gaps in the stabilized *Ammophila* foredune vegetation.

Cordylanthus maritimus (Benth.) ssp. ***palustris*** (Behr) Chuang & Heckard (northern salt marsh bird's-beak, Point Reyes bird's-beak; traditionally Scrophulariaceae , reassigned to Orobanchaceae)

This salt marsh annual forb is found locally in a pocket salt marsh at the north end of Brazil Beach, below the eastern end of the dunes. Its population fluctuates in extremes, ranging from apparent extirpation to co-dominance with common salt marsh forbs. In 2004, after at least 6 years of extreme scarcity or absence, the population surged to many tens of thousands of plants in an area nearly one quarter acre. The subspecies in the Point Reyes area is variable, composed of different "morphs" including a pale gray-green plant with drab whitish, tubular closed corollas (flower petals) scarcely exserted beyond bracts, and a purplish-green, pubescent plant with white and rose-pink/maroon spot inflated corollas well-exserted beyond bracts. The Brazil Beach colony is dominated by the latter, purple-pigmented, showier form.

Glehnia littoralis ssp. ***leiocarpa*** (beach glehnia; Apiaceae) The Dillon Beach locality cited by Howell (1970; reported as the synonym *Cymopterus leiocarpa*) is the historic southern limit of the subspecies. It is rare in California, and occurs mostly Humboldt County and northward on beaches and mobile dunes.

Equisetum* ? aff. x*ferrisii (horsetail; Equisetaceae; putative *Equisetum laevigatum* intergrades with *E.* x *ferrisii*)

A single population of horsetail (scouring-rush, genus *Equisetum*; fern ally) dominates the vegetation of a small, discrete dune slack at the east end of the Tomales dune system, between the south and central dune slack units. The horsetail population appears to be an anomalous low-growing form with inconsistent characters, predominantly of *E. laevigatum* (otherwise rare in Marin County, widespread elsewhere), and some tending towards *E. hyemale*. The population is also anomalously dwarfish, with most plants well under 30 cm tall (significantly below the typical height *E. laevigatum* and *E. hyemale*, even in dune conditions). A range of natural hybrids have been designated *E.* x *ferrisii* Clem (Hauke 1993), but the Tomales Dunes population differs from other coastal Marin populations referred to this hybrid taxon (Howell 1970).

The character combinations in the Tomales Dunes population of *Equisetum* most closely approximate the former taxon *E. funstoni* in California, as described and illustrated in Grillos (1966). *E. funstoni* has been reduced to synonymy with *E. laevigatum* (Hauke 1993), but description of California material by Grillos (1966) is inconsistent with the key and description for *E. laevigatum* in California by Hauke (1993). A comparison of the traits in the variable Tomales Dunes population, Grillos' treatment of *E. funstoni*, and Hauke's treatment of *E. hyemale* and *E. laevigatum* in California is presented in table ....

The characters of the Tomales Dunes *Equisetum* are: main aerial shoots annual to semievergreen, 10-40 cm, slender, with dense basal tufts of lateral shoots (vegetative and fertile), and occasional short lateral shoots on main axes; rhizomes slender. Shoots mostly scabrous, rarely smooth. sheath with 1 or 2 black bands formed by teeth and sheath base: teeth (leaves) blackish with paler margins, deciduous; black base of sheath persisting, 1 – 3 mm wide, irregular, conspicuous. Cones variably obtuse or acute (acute when blackish terminal sporangiophores abort development).

Traits of the Tomales Dunes *Equisetum* that are associated with neither *E. hyemale* nor *E. laevigatum* (as treated by Hauke 1993) include the dwarfish size and form (relatively strong development of basal shoots, short main axis,

usually < 30 cm), and prevalence of well-developed basal shoots. Traits associated with *E. hyemale* but not *E. laevigatum* as treated by Hauke (1993) include the acute cone tip, the well-developed black sheath band or bands, and scabrous stem ridges. *E. laevigatum* traits include the shape of the cone in many (not most) plants, and slender, semi-evergreen aerial shoots. Plants closer to *E. laevigatum* (smoother stems to 40 cm with fewer or no basal shoots) occur in the wettest parts of the dune slack, moist in late spring. It is possible that the population is introgressant in origin, formed by an isolated population of *E. laevigatum* with backcrossed on *E.* x *ferrisii*, resulting in a heterogeneous assemblage of traits. The relatively dwarfish habit is not well explained by growth in nutrient-poor dune sand: *E. laevigatum* commonly grows in moist fluvial sand, and dune forms of *E. hyemale* in Tenmile Dunes are relatively robust.

The Tomales Dunes population is particularly distinctive because of its ambiguous taxonomic affinities. The status of the population is tenuous, because migration of mobile dunes threatens to bury the dune slack and destroy its vegetation, and there appears to be no natural dispersal of the population beyond local clonal spread.

Horsetail-dominated coastal dune communities are generally rare in California. The nearest horsetail-dominated dunes and dune slack vegetation occurs at Tenmile Dunes, Mendocino County, around Inglenook Fen. *Equisetum hyemale* ssp. *affine*, a tall, robust "leafless" horsetail species, is widely established in wet-mesic wetlands (fens and dune lakes impounded by mobile dunes) in extensive clonal (rhizomatous) stands around Inglenook Fen. Its clonal populations tolerate significant sand accretion and well-drained dune sand, and it has colonized the dune ridge that gradually transgresses the edge of the wetlands, rising to high dune elevations. It generally does not occur within the deflation plains of recent dune slacks at Tenmile Dunes however. In terms of species, vegetation dynamics, and dune topography the Tenmile Dunes horsetail vegetation is all respects distinct from the Tomales Dunes horsetail slacks. Dunes and slacks with *E. hyemale* vegetation are uncommon but widespread in North American dune systems (e.g. Antigonish, Nova Scotia; Indiana Dunes).

Equisetum in dune slacks is also reported from Point Reyes dunes (Howell 1970), but stands there are generally uncommon (P. Baye pers. observ.). These "coarse scouring rushes from Point Reyes Peninsula and Bolinas" formerly placed in *E. hyemale* were referred to *E.* x *ferrisii* Clute in the 1969 revision of the Marin Flora, but these robust phenotypes have stronger affinity with *E. hyemale* than *E. laevigatum*.

trait	Tomales Dunes	"E. funstoni" (Grillos 1966)	E. laevigatum (Hauke 1993)	E. hyemale (Hauke 1993)
main axis height	10-40 cm	1.5 – 6 ft	30-180 cm	60-210 cm
branches	dense to few basal tufts infrequent lateral branches on main axis	tufted (short laterals in illustration)	unbranched or branches scattered	unbranched or branches scattered
stem surface	scabrous to slightly scabrous	ridges with many sharply projecting cross-bands of silica (scabrous)	not scabrous	scabrous
stem persistence	weakly evergreen	annual	annual or perennial/evergreen	perennial, evergreen
teeth	blackish deciduous teeth, pale margins	green deciduous teeth;	dark	
sheath	black sheath band	narrow blackish sheath band	no dark sheath band	black sheath band
cones	variably rounded or pointed, slender	tip more or less rounded, cone slender	tip rounded	tip pointed,

Eriogonum latifolium – This widespread and common species of coastal bluffs and dunes is anomalously absent from stable dune scrub and stabilized foredunes of Tomales Dunes.

***Leymus*, (Poaceae; wildryes), including anomalous *Leymus* with intermediate traits of *L. mollis*, *L. pacificus*, *L. triticoides*.**

The grass genus *Leymus* (wildrye) consists of rhizome-bearing species. The Tomales Dunes complex supports populations of all the coastal *Leymus* species found in California (*L. mollis, L.* x*vancouveriensis, L. pacificus*), and also includes apparently unique intermediates that may be undescribed new taxa, or hybrid/introgressant complexes. Other than Tomales Dunes, only Point Reyes dunes contain populations of all these taxa together.

In California coastal dunes, the coarse, gray-green *Leymus mollis* (Pacific dunegrass) was formerly one of the principal native grasses of coastal foredunes, prior to the dominance of marram, or European beachgrass (*Ammophila arenaria*). *L. mollis* is apparently extinct in the main Tomales Dunes sheet, but vigorous populations occur in small landslides in sandstone slumps below seeps above Dillon Beach at its extreme north end. It previously occurred at least locally within the foredunes, but appears to be absent there now.

Around the Dillon Beach parking lot, and along the Brazil Beach shoreline, Vancouver wildrye (*Leymus* x *vancouveriensis* is locally common. *L.* x*vancouveriensis* is a naturally occurring hybrid between *L. mollis* and *L. triticoides* (creeping wildrye, a variable, slender-stemmed, rhizomatous, sod-forming, perennial grass, a widespread species of valleys, alluvial, riparian, and upper salt-marsh edge habitats. L. x*vancouveriensis* is the dominant "dunegrass" of the Tomales Bay shoreline's pocket, while *L. mollis* occurs mostly on the maritime dunes.

A fourth *Leymus* taxon, *L. pacificus* (Pacific wildrye; Figure 16) is an uncommon to rare diminutive *Leymus* species, is restricted to the California coast. It is distinguished by its low-growing, sparse, decumbent colonies, and small, glossy, dark, leathery leaves. It occurs primarily on largely stable old coastal dunes and marine terraces in central and northern California. It is probably underdetected because of its small size, and the rarity of flowering culms needed to identify it. Several populations of typical *L. pacificus* occur at the northeastern corner of the younger Tomales Dunes sheet, and more may potentially occur on unsurveyed portions of the paleodune sheet. One of the *L. pacificus* colonies may be intermediate with *L. triticoides*, which it approaches in some panicle and vegetative traits. *L. pacificus* is rare in Point Reyes dunes, and most populations represented by flowering plants there appear to be intermediate forms with *L. triticoides*. Typical ("pure") populations occur at Marina Dunes (Monterey County) and south of Morro Bay (Hazard Canyon, San Luis Obispo). Rangewide, intermediate forms with the wide-ranging *L. triticoides* are probably more prevalent than the typical *L. pacificus* species; intermediates close to *L. pacificus* occur at the mouths of the Gualala River (Sonoma Co.) Pescadero Creek, and Pomponio Creek (San Mateo Co.) (P. Baye, unpubl. data 1997-2004).

An anomalous intermediate form of Leymus, exhibiting intermediate traits combinations of several coastal *Leymus* taxa, occurs in and around the remnant dune scrub between the bluerock sand quarry road and the dune spring (Figure 15). It occurs sparsely within the old scrub, but has expanded where mobile sand has encroached the scrub, apparently stimulating its growth as the burial-intolerant scrub is reduced. There are several similar clonal populations of this anomalous form. The plants have slight development of a whitish-waxy bloom on the lower leaf surface (a trait pronounced in *L. mollis*, generally present in L. x*vancouveriensis* and some L. triticoides populations), but on leaves and shoots much smaller and shorter than those of *L. mollis*. The form of the mature vegetative tillers is "culmless" (growing apex of true stem below ground), like *L. pacificus* and L. mollis, but unlike L. x*vancouveriensis* and *L. triticoides*, and sheaths are usually strongly reddish sheaths (at least some clones), like most *L. pacificus*). Flowering culms of this plant have been observed only once (1999; Fig. 15), and the panicle is very small, with relatively few widely spaced spikelets, like *L. pacificus*; *L. mollis* and *L.* x*vancoveriensis* have long, spike-like panicles with closely spaced, overlapping spikelets.

The low-growing, spring-head dune population resembles some *Leymus* populations at Point Reyes that appear to be either *L. pacificus* or intermediates between *L. pacificus* and *L. triticoides*. Howell (1970, p. 74) noted "At Dillons Beach a plant was found that resembled *A. arenicola* ["*Agropyron arenicola*" = former name applied to *L. pacificus*] but in its spikelets were frequently paired. The fact that this plant was sterile suggests that it too may be of hybrid origin.". The spring-head population also flowers sparsely, and has deep green, leathery leaves, like *L. pacificus*. This may well be the same Dillon Beach population that Howell noted in his 1949 publication of the Marin Flora.

Howell did not describe the distinctive *Leymus* recently found near the quarry road. The two *Leymus* taxa present in Tomales dunes and vicinity are the *L.* x*vancouveriensis* colonies of Tom's Point, Brazil Beach, and the north end of Dillon Beach, and the complex of *L. pacificus* and putative hybrid *L. pacificus* x *triticoides* population near the spring-head. The presence of these potential parent taxa in close proximity to "hybrid" habitat (moist areas in dunes) indicates a potential for a complex hybrid swarm to form. The anomalous quarry road area *Leymus* does indeed exhibit trait combinations shared in part by all local potential parent taxa.

This may be a unique hybrid population, or (if fertile and stabilized as an old, introgressant population) it may represent a new taxon related to *L. mollis* and *L. pacificus*, possibly *L. triticoides* as well.. The fertility of the plant is difficult to estimate because of the naturally infrequent flowering culms; low seed set would be expected because of either self-incompatibility of few flowering individuals, hybrid sterility, or both. Perennial, rhizomatous *Leymus* species typically have low seed set, and in small populations with low genotypic diversity, they are often circumstantially sterile or nearly so. This is no barrier to ecological success because of the potential for clonal fragmentation and dispersal (shoreline, wind, gravity) and clonal spread by rhizomes. The naturally infertile hybrid *L.* x*multiflorus* is a widespread and often dominant species of valley grasslands.

It is not known whether the anomalous *Leymus* populations are recent expansions of an old, isolated relict population or species, or whether it is a relatively recent hybrid swarm. The presence of the plant within the older dune scrub suggests that it may bean older remnant recently expanded by encroachment of mobile dunes, because no suitable seedling habitat is present in the existing scrub or mobile dunes. The proximity of the site to a complex of springs suggests the likelihood of past moist dune sand seedling habitats during earlier phases of dune migration; these may have provided suitable ancient sites for former hybrid seedling establishment.

The genetic and taxonomic status of the putative introgressant or hybrid *Leymus* intermediate at Tomales Dunes warrants further study. Specific research questions would include: whether the population in fact consists of multiple genetic individuals; whether the populations are capable of producing viable seed; whether seedling phenotypes are similar to parent populations or segregate into trait combinations of putative parent species; and whether genetic markers diagnostic of putative parent species are present in the population. These questions would be essential to resolving the taxonomic status of the population (species, old stable introgressant, recent hybrid).

Lupinus tidestromii E. Greene (Tidestrom's lupine; Fabaceae, pea family)

The rare and endangered *Lupinus tidestromii*, a low-growing silvery perennial forb, was reported from Dillon Beach in 1992, but has not been observed since then. The species is known primarily from Point Reyes dunes south of Abbott's Lagoon, and a managed relict population in Monterey Peninsula dunes. It has also been reported from Goat Rock dunes (Russian River, Sonoma County). Despite extensive searches for this species and L. chamissonis at Tomales Dunes since 1998, I have not recovered any *L. tidestromii*, despite familiarity with its populations at Point Reyes.

If the identification of *L. tidestromii* at Dillon Beach was accurate (no voucher or photo is known to be available, and no species expert is known to have confirmed the original field identification), it is possible that it may persist at Tomales Dunes in the form of a long-lived dormant seed bank. Cattle trampling and intensive recreational use of the western dunes, however, may minimize the viability of any recruited population. Much suitable habitat for the species occurs at Tomales Dunes away from intensive recreational use areas.

Lupinus chamissonis Eschsch.***, L. arboreus*** Sims (silver dune lupine, yellow bush lupine; Fabaceae, pea family)

Lupinus chamissonis is conspicuous by its absence at Tomales Dunes. *L. chamissonis* is a large, silver-gray shrub with spikes of pale blue-violet, fragrant flowers. It is ecologically restricted to coastal dunes, and is distributed in California from Bodega Dunes (on old dune remnants) south to San Diego, and south. *L. chamissonis* is abundant in older dunes of Point Reyes, and was noted as part of the original pre-reclamation dune vegetation in the 1860s (Bolander 1863, reported as *L. albifrons*, from which it was later distinguished). It appears to be entirely absent from Tomales Dunes. An atypically silvery-pubescent form of yellow bush lupine (*L. arboreus*) prevalent in Tomales Dunes, resembling *L. chamissonis* in its vegetative state, has apparently been misidentified

as *L. chamissonis*. This atypical silvery, mounded form also occurs in Salt Point State Park, Sonoma County, and a similar one with blue flowers occurs at Point Arena (Manchester, Mendocino County) dunes – both locations where introgression with the silky-pubescent native *L. variicolor* is suspected. Monk and Associates (1999) recently reported *L. chamissonis* from Dillon Beach dunes, but this appears to be an error. Cooper (1967), however, did describe the vegetation of the dune ridges of Dillon Beach as co-dominant *L. chamissonis* with *Ericameria ericoides*. The complete replacement of this species with *L. arboreus* is unlikely, and the Cooper report may have been a casual error as well.

Lupinus arboreus is one of the dominant species in dune scrub at Tomales Dunes today, but it is doubtfully native to coastal dune systems, particularly north of San Francisco Bay. W.S. Cooper's exhaustive surveys of California dunes and their vegetation in the early 20th century indicated that *L. arboreus* was "hardly a typical member of the dune community", in contrast with *L. chamissonis*, which he described as "one of the most characteristic dominants in the dune shrub community" (Cooper 1936). The early historic geographic range of *L. arboreus* published in the first flora of California, based on field surveys of the 1860s-1870s (Brewer *et al.* 1880) was "from Sacramento Valley to San Diego….used successfully as a protection against drifting sands". It was deliberately introduced to complete stabilization of coastal dunes in San Francisco, immediately following initial stabilization with European beachgrass (*Ammophila arenaria*; McLaren 1924). The history of its introduction to the north coast of California (Miller 1987) for similar purposes of protecting economic uses of land encroached by active dune migration, and pre-reclamation accounts of its geographic and ecological distribution, indicate that it was probably introduced to Tomales Dunes, along with *Ammophila*, to protect valuable rangeland against dune encroachment.

Lilaeopsis occidentalis, (Western lilaeopsis ; Apiaceae, carrot family)

Lilaeopsis occidentalis is an inconspicuous, low-growing, clonal herb with linear, terete (rounded) hollow grasslike leaves, forming sparse turfs with its spreading networks of threadlike rhizomes. It occurs primarily along the shores of Pacific coastal lagoons from Marin County to British Columbia, often where water levels fluctuate seasonally or unpredictably, and vary from fresh to brackish conditions. It also occurs uncommonly in tidal estuarine marshes or shores where vegetation cover is sparse and open, also usually in brackish conditions. In Marin County, *L. occidentalis* occurs locally in unstable populations at Rodeo Lagoon, Abbott's Lagoon (Howell 1970; P. Baye, pers. observ.), a few Tomales Bay shoreline localities, and Tomales Dunes. It is rare and local in the stream-mouth lagoons of the Russian and Gualala Rivers in Sonoma County. Tomales Dunes support the only extensive populations in coastal dune slacks with seasonal wetland plant communities. *L. occidentalis* occurs as a ground layer species in *Scirpus pungens-Eleocharis macrostachya* dominated marsh vegetation of the northern dune slacks at Tomales Dunes, and until recently (2002) formed extensive stands in young wet dune slacks (minimal soil development) at the central eastern portions of the dunes, in which it was an abundant to dominant component of the vegetation. The established central eastern *L. occidentalis* slacks have been buried by transgressive dunes (2003-4), but may regenerate as new slacks form. The Tomales Dunes populations are among the largest, if not the largest, in the southern portion of the species' range. *L. occidentalis* currently has no special legal status, but it occurs in far fewer localities and arguably less stable populations than the closely related Mason's lilaeopsis (*L. masonii*, restricted to the eastern San Francisco Estuary/Sacramento River), a state-listed species.

Sagina maxima A. Gray ssp. ***crassicaulis*** (S. Watson) G. Crow (coast pearlwort; Caryophyllaceae, carnation family). *Sagina maxima* ssp. *crassicaulis* is a tiny, tufted, prostrate herb with tiny white flowers. It typically occurs in moist seeps of sandy or sandstone coastal bluffs from Marin County to Alaska. Dillon Beach is the type locality of *S. crassicaulis* S. Watson, which was later reduced to a subspecies of the more widespread *S. maxima*. It occurs on bluffs north of Dillon Beach, and (at least until 2002) in crevices of bedrock outcrops at the crest of the highest climbing dune peak of Tomales Dunes.

Tanacetum camphoratum Less. (dune tansy; Asteraceae, daisy or aster family)

Tanacetum camphoratum forms a variable complex of populations along the California coast from San Francisco/northern San Mateo to southern British Columbia. It is restricted to coastal dunes, and it is uncommon throughout its range. It was formerly treated as two distinct species, *T. douglasii* of northern California to B.C., and the rarer *T. camphoratum* from southern Mendocino to Francisco-San Mateo coast.

Tomales Dunes is the locality of the only remaining population in Marin County. Howell (1970) reported the species only from Rodeo Lagoon, where it is now extirpated; the Dillon Beach locality was overlooked. Here it occurs in a cluster of clonal populations in the dunes surrounding the northwestern slacks.

The Tomales Dunes population of *T. camphoratum* consists of about 5 discrete colonies in dune-slack ecotones at the northwest end of the dune slack complex. It more closely resembles the nearest population to the north at Manchester (Point Arena) dunes, Mendocino County, compared with than the much closer San Francisco population. The San Francisco population has tall, coarse, rope-like, gray-green decumbent shoots with dense gray-white woolly leaves, and minimal development of ligules in ray florets. The Tomales Dunes population is both rhizomatous and decumbent /stoloniferous (lateral rooted stems below rather than above ground, but also sprawling above-ground), with slender reddish but white-woolly shoots, and smaller leaves. But in its floral characters (consistent suppression of ligules in ray florets), it is more similar to the San Francisco population. Populations from Humboldt County north (formerly *T. douglasii*) generally lack the dense grayish pubescence, and have conspicuous ligules in ray florets, and are strongly rhizomatous.

The Tomales Dunes and Manchester Dunes populations may be remnants of isolated intermediates between ancestral southern and northern extreme entities in the species complex. Like the Tomales Dunes population, the Manchester population occurs only locally in dunes adjacent to seasonal wetlands of the dune slack complex.

***Triglochin striata* R. & P**. This diminutive, slender, grasslike plant in the arrow-grass family (Juncaginaceae) is normally found in California only in fresh-brackish estuaries and shallow, soft beds of tidal river mouths. Howell (1949) reported "In Marin County [it is] only known from the marshy pond behind the beach at Dillons Beach". It was recently confirmed there on July 31 by Randy Zebell and P. Baye, and in a dune slack pond on August 8 by P. Baye. It grows in a low sparse turf below other low herbs, rushes, bulrushes, grasses, and spikerushes, often where pond bottoms are recently emerged.

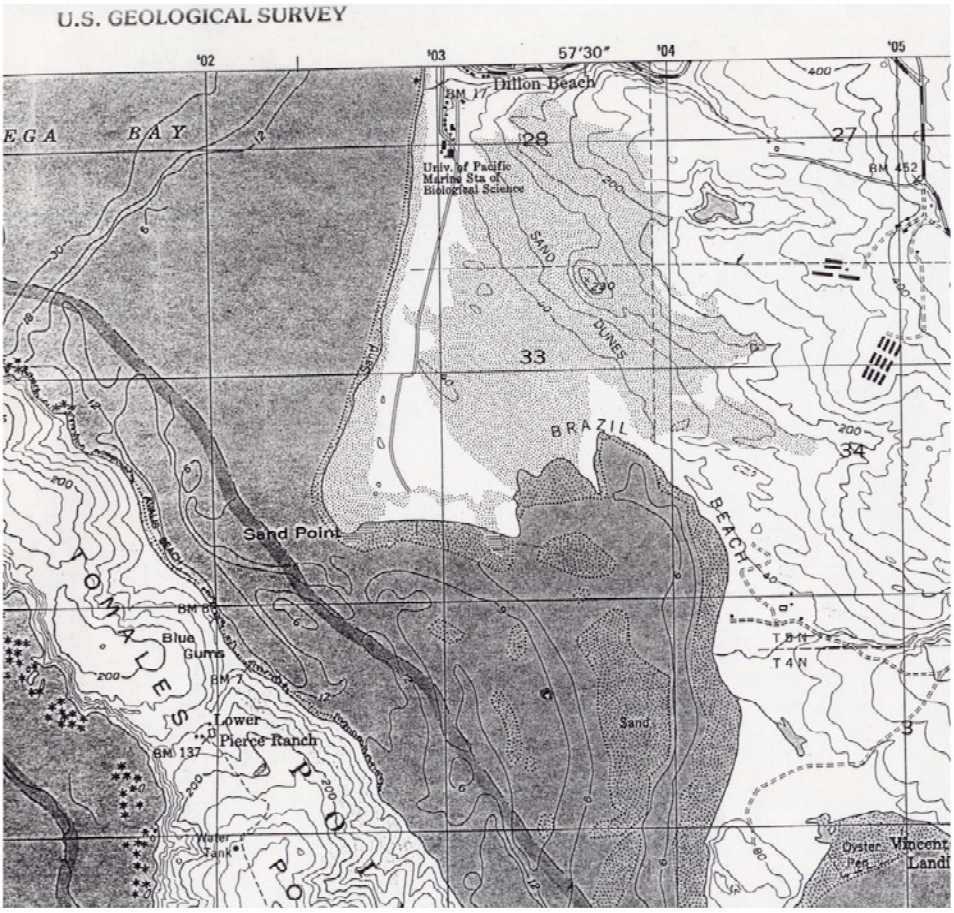

Figure 1. Vicinity map of Tomales Dunes complex: Sand Point, Dillon Beach, to mouth of Walker Creek, Tomales Bay (U.S. Geological Survey, Tomales Quadrangle)

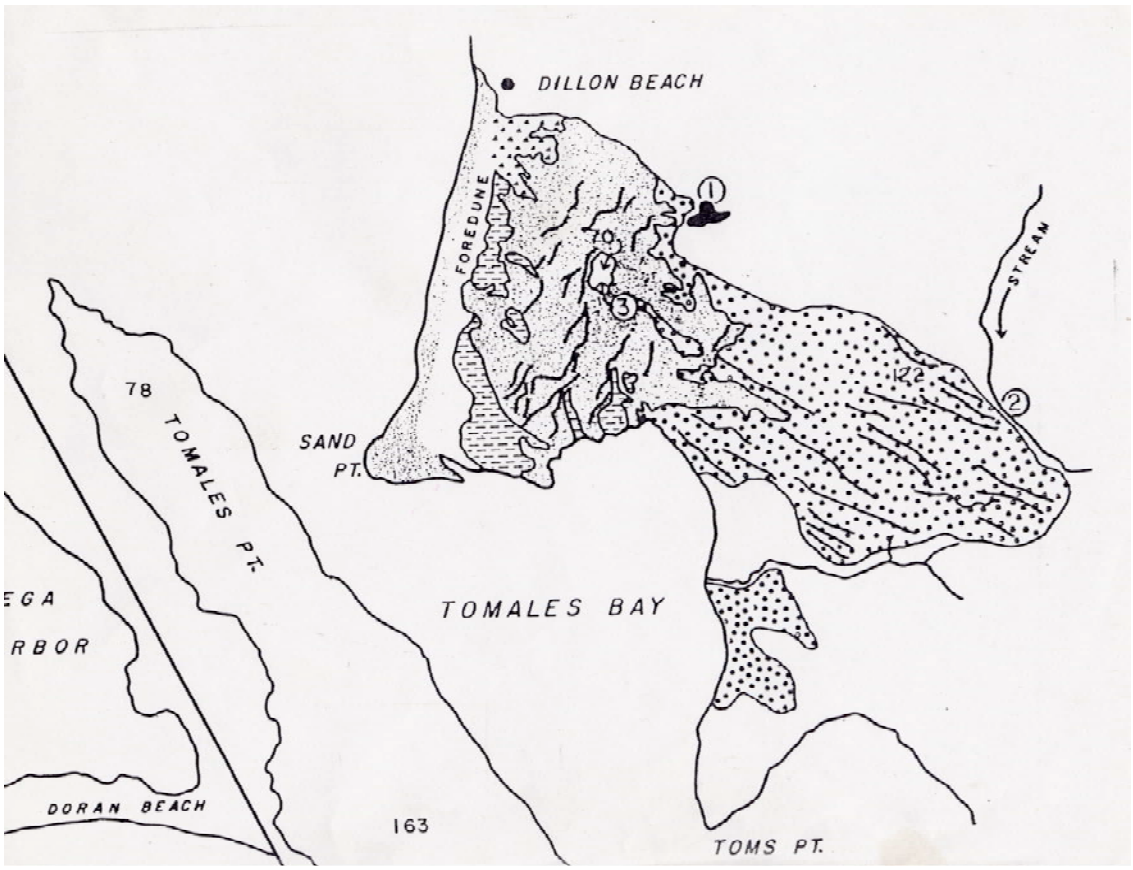

Figure 2. Map of the Tomales Dunes sheets and landforms, adapted from W.S. Cooper (1967). Horizontal hatching: dune slack wetland. Stippled/dotted: older dune sheet (early Holocene or earlier). Stippled/tone: younger dune sheet, transverse dune complex. 1: perennial dune-dammed pond at edge of dune sheet. 2: stream deflected by older dune sheet. 3: steep bedrock hill outcrop (likely former sea stack) mantled with climbing dune (colloquially "Little Sugarloaf")

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